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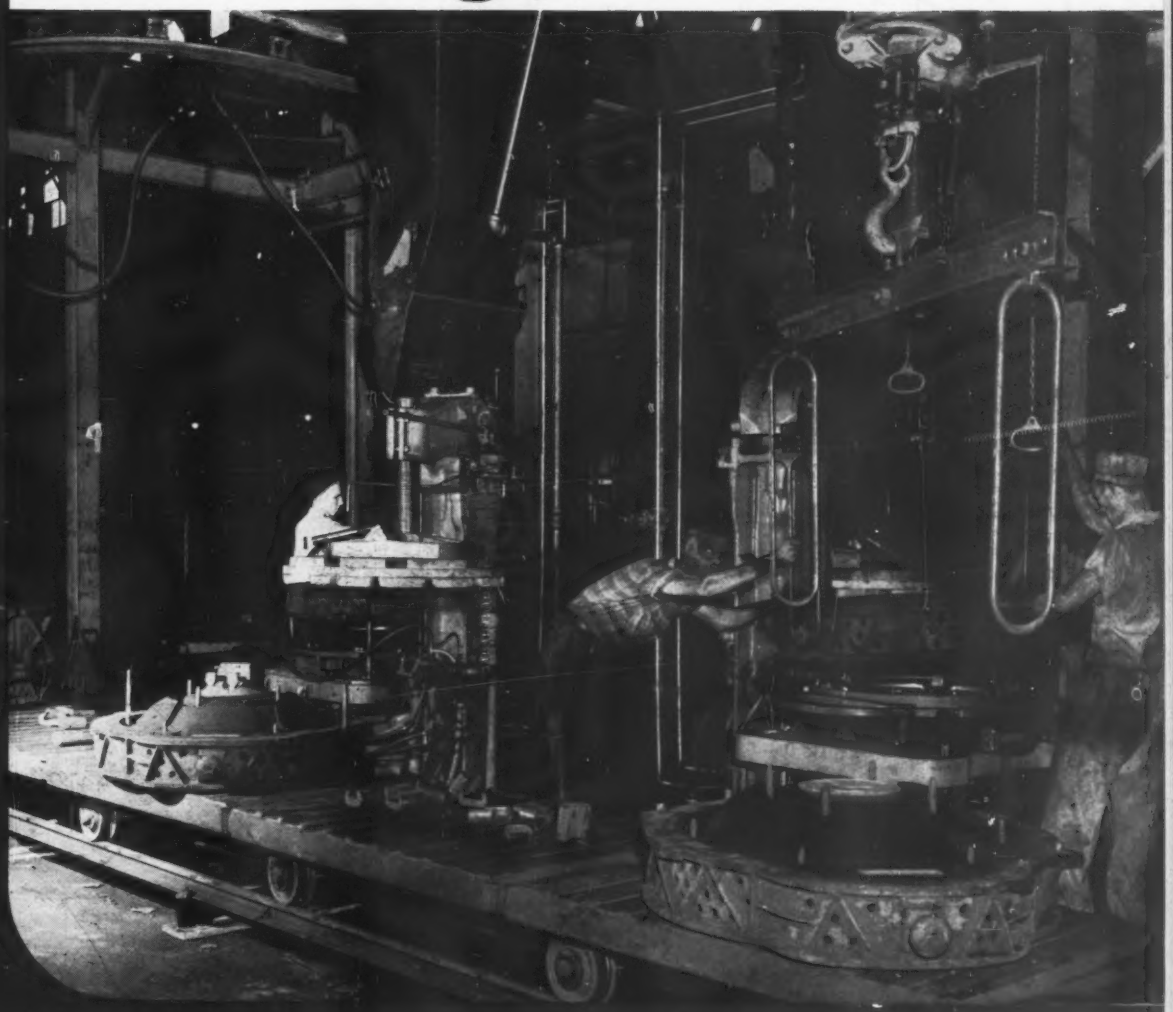

August 1945 — Gamma Ray Radiography (p. 30). Grain Refinement of Magnesium Alloys (p. 34). Colorimetric Determination in A Combined Form (p. 45). Sand Reclamation (p. 49). Welding Gray Iron Castings (p. 60). Equipment in Precision Casting (p. 65). SAE War Engineering Board Report (p. 72).

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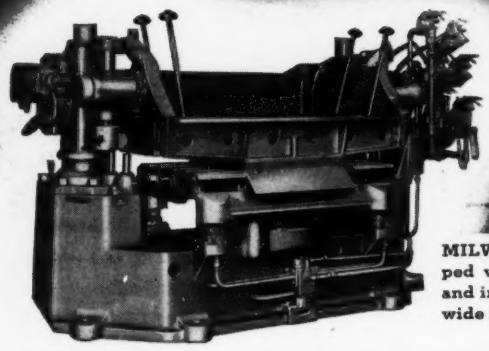

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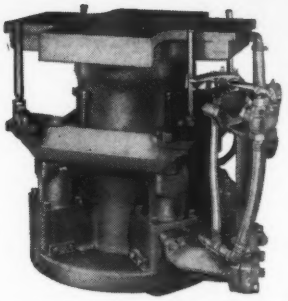

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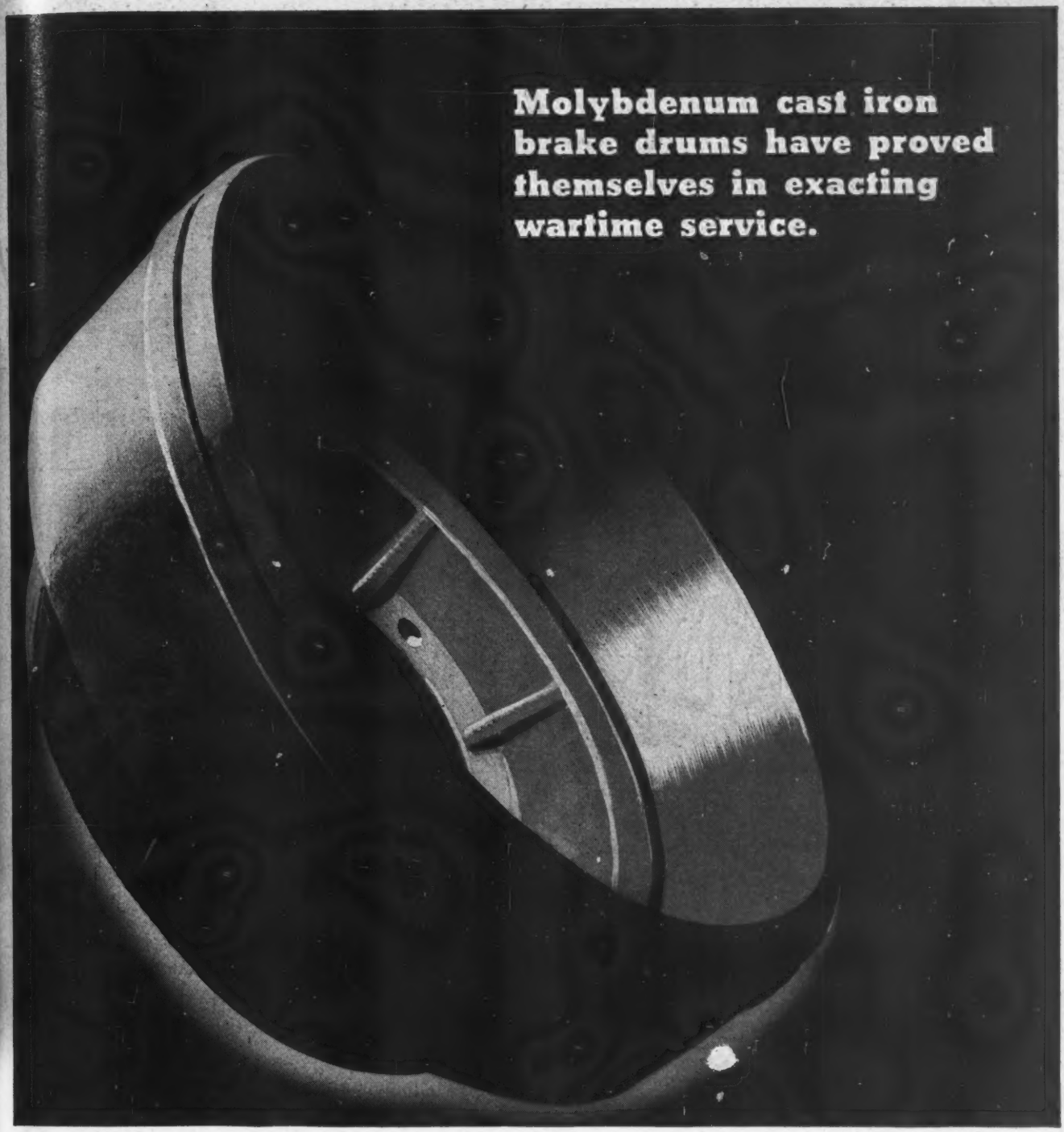

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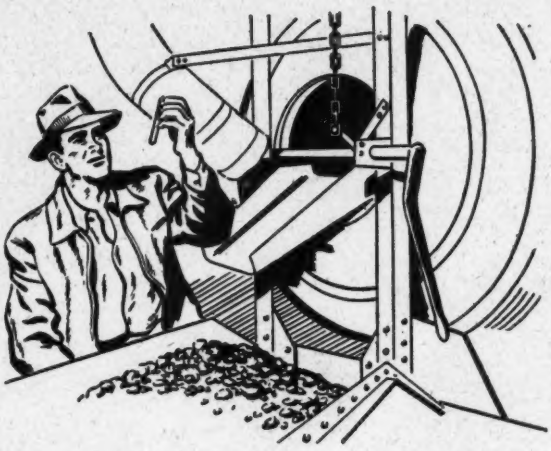

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American Foundryman

AUGUST 1945

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Number 1

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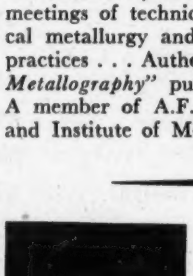
WHO ARE THE AUTHORS *In This Issue?*

The men whose names are shown on these two pages deserve the thanks of the industry for their contributions to the 1945 "Year-'Round Foundry Congress" . . . in many cases, completed in spite of cancellation of the Detroit convention.

L. W. Eastwood

Co-author (with James A. Davis and J. C. DeHaven) of *Grain Refinement of Magnesium Casting Alloys* . . . Born in Wiota, Wis. . . . Attended University of Wisconsin, Madison, Wis., and received his Bachelor of Science degree in metallurgy, 1929 . . . Obtained his Master of Science degree, 1930, and Ph.D. one year later . . . Appointed assistant professor at Michigan College of Mines, Houghton, Mich., 1931-1935 . . . Became affiliated with Aluminum Co. of America, Cleveland, in 1935 as research metallurgist . . . Vice President of the Maryland Sanitary Mfg. Corp., Baltimore, 1942 . . . Present position, assistant supervisor at Battelle Memorial Institute, Columbus, Ohio . . . Has written extensively for the trade press and meetings of technical societies on physical metallurgy and non-ferrous foundry practices . . . Author of *"Introduction to Metallography"* published in 1931 . . . A member of A.F.A., A.I.M.E., A.S.M. and Institute of Metals (British).



Ronald Webster

In this issue: See *Sand Reclamation* . . . Co-author, Adrian C. Den Breejen . . . Mr. Webster is a native of Evanston, Ill. . . . Graduated in 1912 from Williams College, Williamstown, Mass. . . . A member of Phi Beta Kappa honorary society . . . Following graduation became a reporter in Chicago for the City News Bureau . . . Was also an editorial writer for Chicago Tribune . . . During World War I saw service in U. S. Army . . . Returned to Chicago and assumed an executive position in the laboratory of Fansteel Metallurgical Corp. . . . In 1919 was named Secretary of the firm and held that position until 1929 . . . Journeyed to Switzerland during 1929 and studied at University of Lausanne . . . Following a number of years, turned to the foundry industry as a career . . . Joined Hydro-Blast Corp., Chicago, in 1935 and is Vice President of that firm . . . An A.F.A. member.

Adrian C. Den Breejen

Co-author with Ronald Webster . . . See: *Sand Reclamation* . . . Mr. Den Breejen was born in Amsterdam, Holland, June, 1913 . . . Attended Armour Institute of Technology, Chicago, in 1932 . . . Began his industrial career that same year with W. A. Jones Foundry & Machine Co., Chicago, as a molder's apprentice . . . Assumed a similar position with Nichol-Straight Foundry Co., Chicago, during 1933-1934 . . . Having completed apprenticeship training, gained a wealth of knowledge and experience as a molder during the following three years at Oklahoma Brass & Iron Co., Oklahoma City, Okla.; Nichol-Straight Foundry Co. and Furgeson & Lange Foundry Co., Chicago . . . Was foundry instructor at University of Minnesota, Minneapolis, from 1938-1939 . . . Became associated with Perfection Mfg. Co., Minneapolis, as foundry superintendent, during 1939 . . . Joined Hydro-Blast Corp., Chicago, the following year as a foundry sand technician . . . Has spoken before many A.F.A. chapters on sand reclamation . . . An A.F.A. member.

DISCUSSION WANTED!

The men who are recognized on these Who's Who pages each month have spent considerable time and effort in preparing their papers for presentation herein, and the value of their findings can be materially enhanced through discussion. Since oral discussion is not possible this year, written discussion is earnestly solicited!

Members of A.F.A. owe it to these authors to take a definite interest in their work. Written discussion should be forwarded direct to A.F.A. headquarters in Chicago, for publication in future issues of *American Foundryman*.

W. B. Sobers

Chemist, Chain Belt Co., Milwaukee . . . Author of current paper on *Colorimetric Determination of Nickel and Chromium in a Combined Form of Analysis* . . . Born in Arrow, Pa. . . . Began industrial career as a laboratory assistant for Lycoming Mfg. Co., Williamsport, Pa. . . . In 1928, assistant chemist with National Brake & Electric Co., Milwaukee . . . A year later was foundry chemist with Bethlehem Foundry & Machine Co., Bethlehem, Pa. . . . In 1930 joined Federal Foundry Supply Co., Cleveland, as control chemist . . . Following year was appointed metallurgical chemist, A. O. Smith Corp., Milwaukee . . . Since 1935 has been affiliated with Chain Belt Co. . . . Member of A.S.M.

J. C. DeHaven

In this issue: See *Grain Refinement of Magnesium Casting Alloys* . . . Co-author with L. W. Eastwood and James A. Davis . . . Mr. DeHaven's birthplace was Glenshaw, Pa. . . . Matriculated at Dartmouth College, Hanover, N. H., and received his A.B. degree in 1933 . . . Obtained his Master of Science degree from Carnegie Institute of Technology, Pittsburgh, Pa., 1935 . . . Upon entering industry became affiliated with American Radiator & Standard Sanitary Corp., Pittsburgh, Pa., until 1941 as chemist and industrial engineer . . . Joined Battelle Memorial Institute, Columbus, Ohio, as research

engineer in 1941 . . . An active member of A.F.A. and A.S.M.

Roy A. Gezelius

Author of paper herein on *Advantages and Disadvantages of Gamma Ray Radiography* . . . A native of La Grange, Ill. . . . Earned his Bachelor of Science degree in industrial chemistry at Michigan State College, Lansing, Mich., 1929 . . . A year later (1930) obtained a Master of Science degree in Metallurgy from the same institution . . . Upon entering industry joined Naval Research Laboratory, Anacostia Station, Washington, D. C., and remained there eight years . . . In 1938, became connected with Taylor-Wharton Iron & Steel Co., High Bridge, N. J., as metallurgist . . . Two years later joined General Steel Castings Corp., Eddystone, Pa., as metallurgist and is now chief metallurgist . . . Has written fluently for the trade press and technical societies on the subjects of gamma ray and solidification and contraction in steel castings . . . Is a member of A.F.A., A.I.M.E. and A.S.M.

James A. Davis

See paper on *Grain Refinement of Magnesium Casting Alloys,* authored by Mr. Davis and associates, J. C. DeHaven and L. W. Eastwood . . . Born in Ada, Ohio . . . A graduate of Colorado School of Mines, 1939 . . . Appointed as metallurgist, Colorado Fuel & Iron Co., Pueblo, Colo., and was associated with this firm until 1943 . . . At present is a member of the engineering staff, Battelle Memorial Institute, Columbus, Ohio . . . A member of A.S.M.

Capt. A. J. Dore

See paper: *Equipment Trends in Precision Casting* . . . Received Bachelor of Science degree in mechanical engineering, University of Illinois, Urbana, in 1932 . . . Post-graduate work in electrical engineering at Illinois Institute of Technology, Chicago, and Massachusetts Institute of Technology, Cambridge . . . Began his engineering career in the hardware industry as an industrial and management engineer from 1934-1936 . . . Was affiliated with a communications equipment manufacturer until 1938 as an industrial engineer . . . During 1938 became a research engineer for an electro-mechanical apparatus company . . . Has been on active duty as an officer in the Ordnance Department since 1942.

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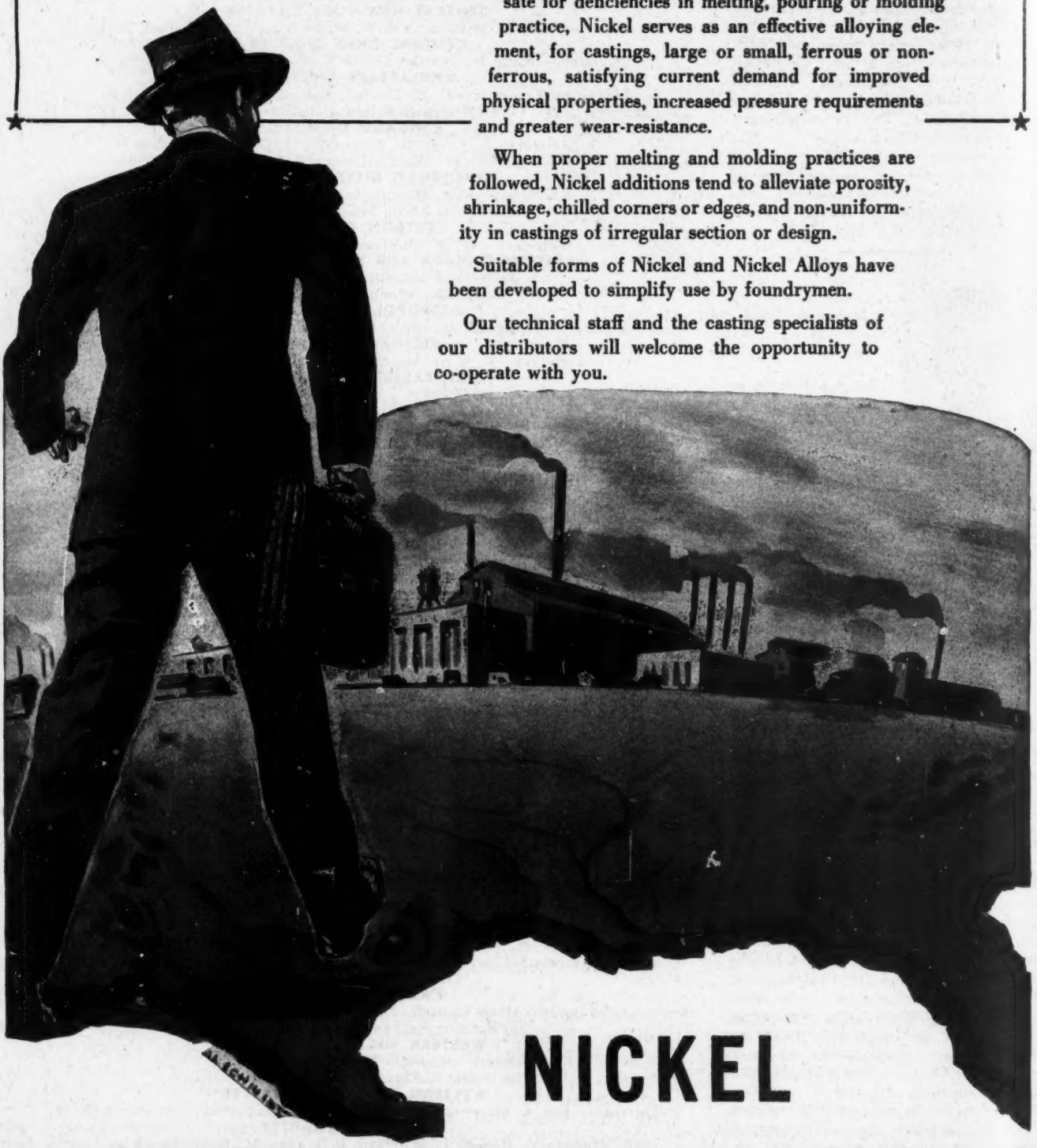

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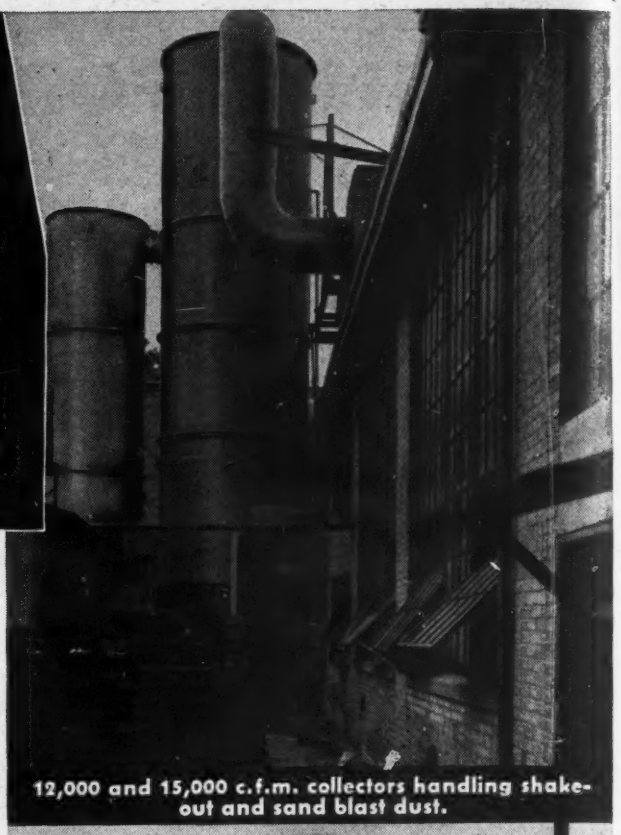

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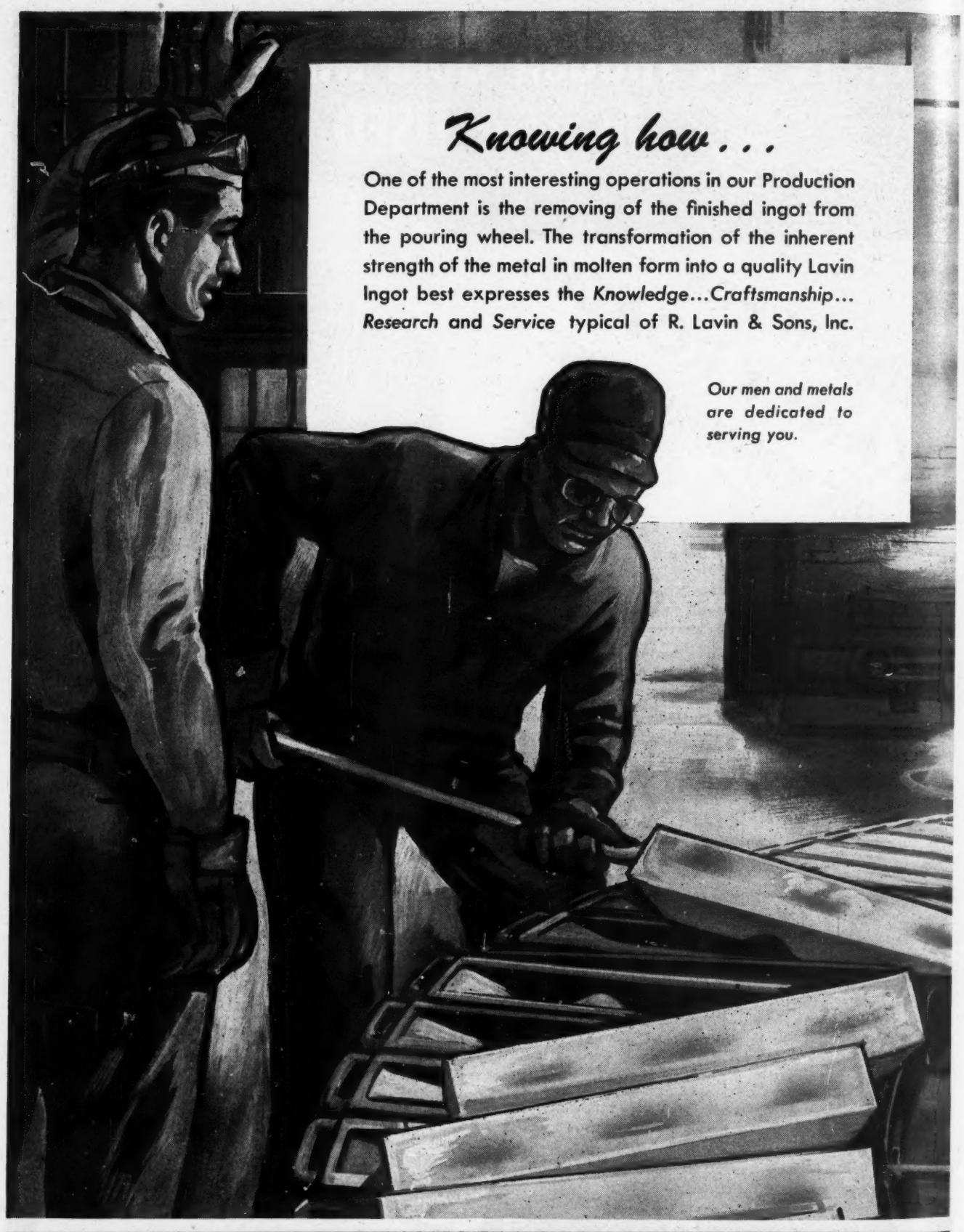
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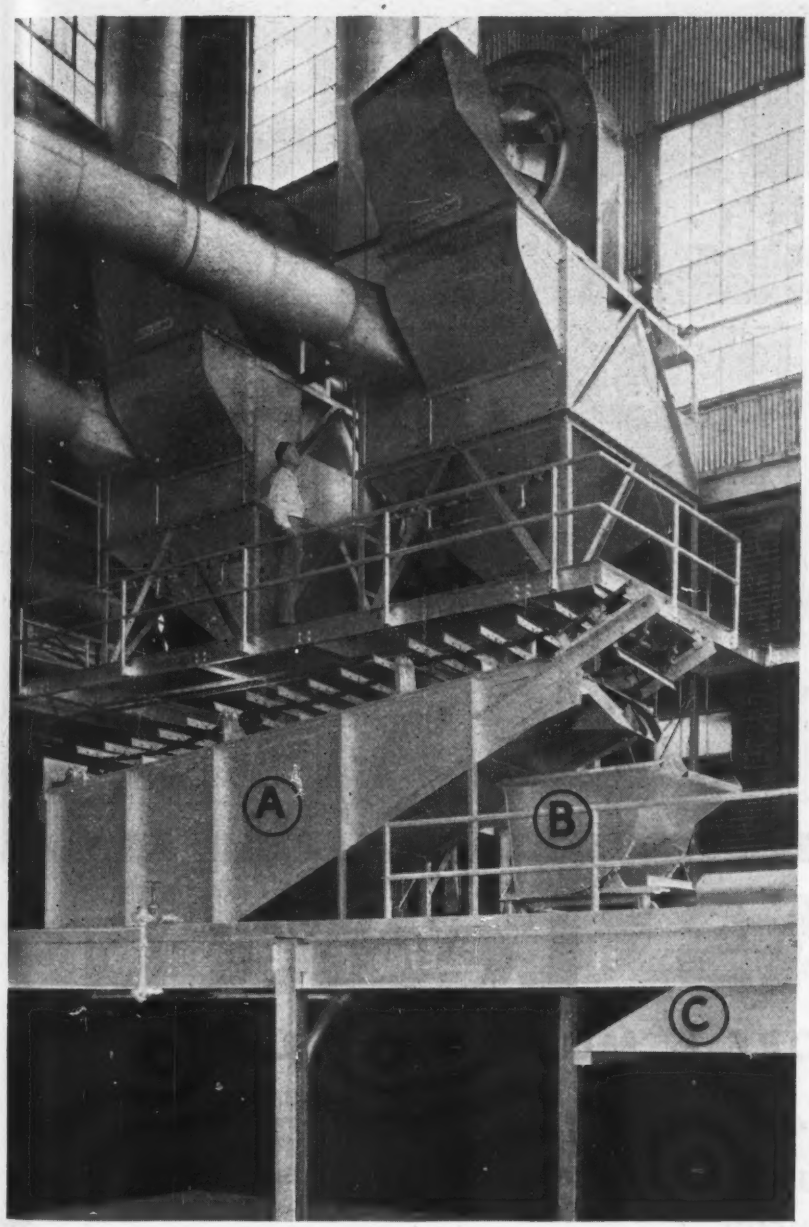

Roto-Clones can be readily arranged for central sludge disposal when desired. In this installation, the sludge water drains by gravity into a central settling tank (a) which is equipped with automatic ejector for continuous removal of the settled sludge. Ejector drops sludge into a receiving bucket (b) from which it can be dumped onto tilting chute (c) for discharge into truck on ground floor.

THESE two No. 27 Type W. Roto-Clones effectively control the dust from sand conditioning equipment, and exhaust the required amount of fines, to insure uniform permeability of the molding sand, in a large steel foundry recognized for the outstanding quality of its castings. Roto-Clone offers complete dust control for all foundry operations, including shake-out, sand handling, screens, mullers, tumbling mills, blasts, grinders, etc.

The advantages of compact design, and the adaptability of the Roto-Clone to overhead installation when floor space is limited, are well illustrated in the pictures shown here. Write for descriptive bulletin No. 274A.

ANOTHER AAF PRODUCT

AMERICAN AIR FILTER COMPANY, INC.
Incorporated
104 Central Avenue — Louisville, Ky.
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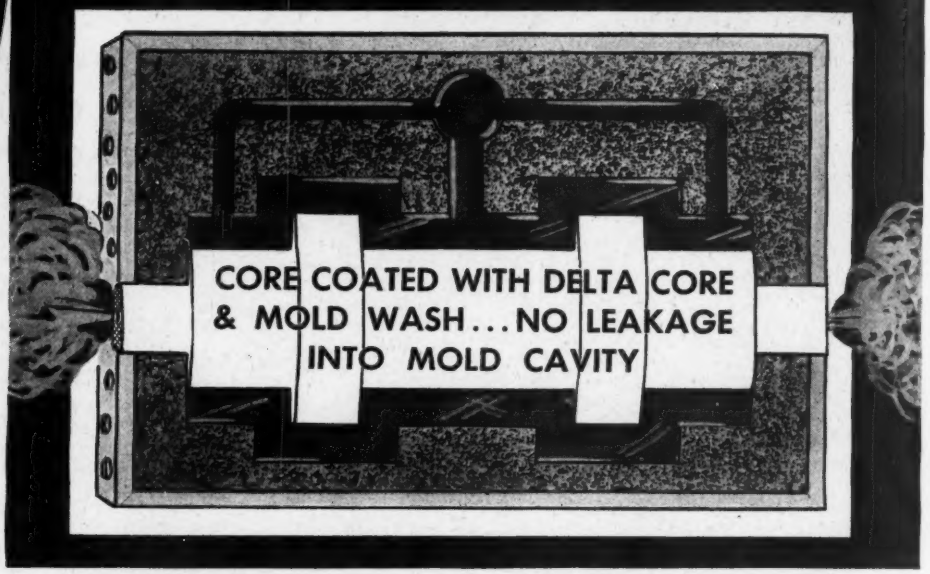
ROTO-CLONE

FOR EVERY FOUNDRY DUST PROBLEM

why MORE FOUNDRIES USE DELTA CORE & MOLD WASHES

REASON No. 3



NO GAS Leakage

THROUGH DELTA CORE & MOLD WASHED SURFACES

Gases produced by decomposition of organic binders in the core sand cannot leak through DELTA Core and Mold washed surfaces to contact the molten metal.

Only DELTA Core & Mold Washes provide this unique and all-important insurance against defective castings resulting from gas leakage.

DELTA Core & Mold Washes insure more perfect castings with finer finished surfaces.

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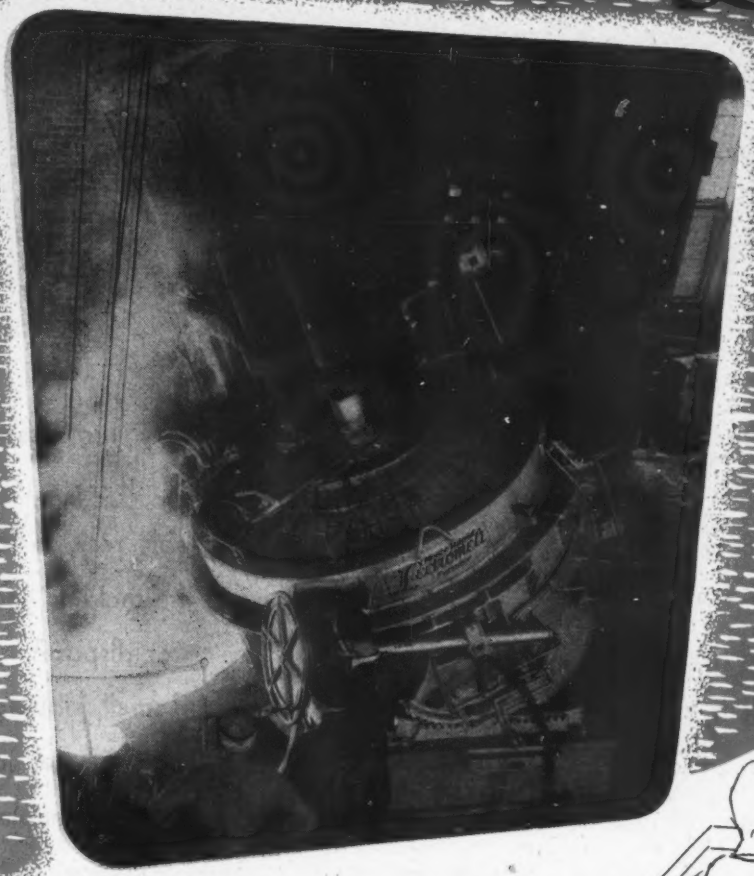

base your plans on Lectromelt top-charge furnaces

Definitely, the Moore Rapid Lectromelt Furnace of the Top-Charge Type has demonstrated the following four points so vital to plant operation in the melting of steel and iron:

- Improved Quality
- Increased Production
- Lower Operating Costs
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The consistent record of more than eight hundred Lectromelt Furnaces in use throughout the world is an assurance of efficient, economical performance.

These advantages are the result of thorough, time-tested engineering, and of careful, year-after-year study of Lectromelts in operation. Simplified mechanisms and sturdy construction make for uninterrupted service and long life.

Lectromelts therefore merit your most careful attention when planning plant additions or replacements. Catalog mailed on request.

PITTSBURGH LECTROMELT FURNACE CORPORATION
Pittsburgh 30, Pennsylvania

This is a...

HYDRO-BLAST OPERATOR

AT WORK

TAKE a good look at this Hydro-Blast casting cleaning room where sand and water is propelled at high velocity to knock out hard complex cores and surface clean the castings.

No dust is visible to the naked eye because the dust level (by actual count) is extremely low. Hydro-Blast cleaning rooms require no roofs and no artificial ventilation. In fact, a large area surrounding the room is cleaned by this modern water sand blast.

Another outstanding feature obtaining to the Hydro-Blast method of cleaning castings is the room temperature which is always cooler during the hot months and warmer during the winter.

Hydro-Blast cleans the casting rapidly, economically and thoroughly. It shoots hard complicated cores which usually require pneumatic punching. It removes every semblance of core sand and blasting sand. It separates the latter and returns the usable residue to the storage tank. It delivers the molding sand to the hopper for reclaiming or disposal.

Every foundry, large and small, jobbing and production, gray iron and steel, can profit from the superior advantages obtainable only from wet sand blasting. Hydro-Blast will gladly furnish details of design and results being secured under actual working conditions.

Dust and Dirt in the place I work
Is now a thing of the past.
We told our boss so he came across
And installed the Hydro-Blast.

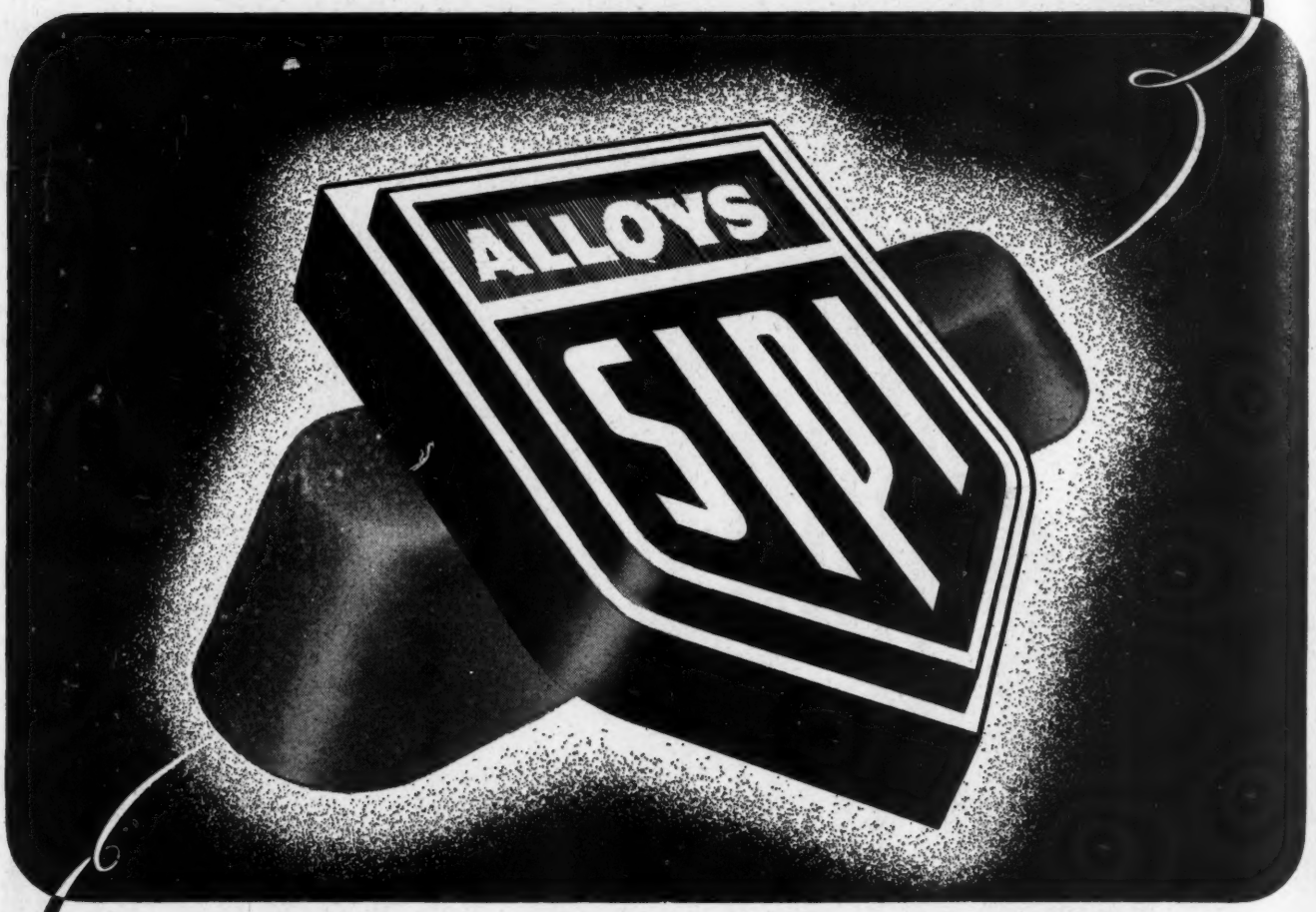
Submitted by: M. E. Dolan, Wheel Dept., L & N Railroad Co., Louisville, Ky.

Hydro-Blast

2550 North Western Avenue,

Chicago 47, Illinois

A reliable name... IN ALLOYS



BRONZE INGOTS... from this institution are always uniform in quality—for excellent reasons. They are backed by years of experience and a tradition that permits no compromise with quality. SIPI is more than a trade mark. It is a symbol in alloys—as reliable a name as sterling on silver. The SIPI shield on an ingot is your guarantee that it meets the exacting specifications of industry and that it is the result of tireless research by skilled laboratory and plant technicians.

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REDUCE SCRAP LOSSES

BY MOISTURE AND STRENGTH CONTROL

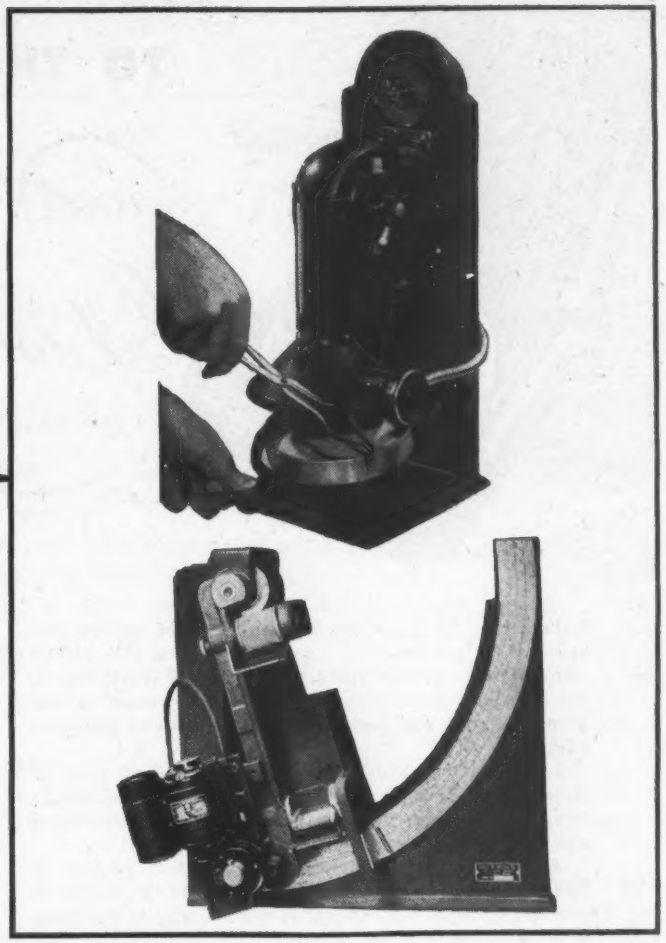
THE MOISTURE TELLER is the ideal moisture determination tool for either the plant or the laboratory.

The Moisture Teller, together with a balance, may be placed in the foundry at the mixing station. It becomes a simple task to control the moisture content of sands, resulting in better castings and reduced scrap losses.

When equipped wih a thermostat, the Moisture Teller may also be used to determine the exact moisture content of magnesium sands.

In the laboratory, the Moisture Teller is not only well suited for the accurate and rapid moisture testing of sand, but it is equally useful for determining the exact moisture content of a wide range of other granular materials.

THE UNIVERSAL SAND STRENGTH MACHINE WITH MOTOR DRIVE performs a wide variety of strength tests on molding sands, clays, cores and core pastes. Through green and dry strength control of foundry sands, many other physical properties of a sand are largely stabilized. Strength control will enable you to standardize the ramming of molds.



SAVE MAN HOURS

The carbon content of metals is now beginning to receive full and due attention from plant personnel.

With the ARL-DIETERT Carbon Determinator and Varitemp Furnace, the carbon content of metal may be determined while the metal is still in the furnace or cupola. In the case of steel, a sample of metal is chilled in a water bath, and iron is chilled in the specimen mold. The carbon is determined within 2 minutes with the ARL-DIETERT Carbon Determinator. This equipment is suitable for furnace preliminaries and laboratory finals. It is also suitable for both graphitic and total carbons.

The Varitemp Combustion Furnace is also recommended for use with the 2 Minute Sulfur Determinator. Contained within the single unit are the furnace, transformer, pyrometer, oxygen valve, voltage switches and power switch. Temperatures range up to 2750 deg. F.

Write for descriptive leaflet and formal quotation.

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Distinguished Service

With a total of 2 trillion, 256 billion, 334 million ton-miles of freight service . . . and 254 billion, 194 million miles of passenger service since the start of World War II, the railroads of America have achieved a record of performance that will live forever in the annals of industrial history!

Federated is proud to salute the railroad men of America for doing a marvelous job despite the handicaps of labor shortages, deteriorating equipment and delivery delays.

And proud, too, that nearly two billion pounds of Federated non-ferrous metals supplied to the railroads and other American industries are helping to pave the way to ultimate victory.

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METALS DIVISION
FMD
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Nation-wide service with offices in principal cities

ONE OF A SERIES OF ADVERTISEMENTS DEDICATED TO THE PRODUCTIVE ROLE OF AMERICAN INDUSTRY IN WORLD WAR II

Future Foundry Efforts Involve Understanding of Human Beings and Material

WITH the membership in A.F.A. constantly increasing, your Board of Directors is alert to the growing requirements of the members and of the castings industry as a whole. Those requirements are reflected in the actions taken at the Annual Board Meetings held during the week of July 16.

It is recognized, for example, that the practical problems concerning the foundry industry should not be overshadowed by the technical problems. Through continued cooperation and organized effort, we shall meet the challenges that will surely confront us during the reconversion period ahead.

Two factors, human beings and material, provide a common ground for all our future efforts. The time has come when we must understand that the limitations of human beings are just as important to the foundry industry as are the limitations of the materials and the processes employed in our work. With this consciousness before us, I am convinced that we will be able to make the adjustments necessary, and as a result win the respect, in both the social and industrial world, that we have earned and deserve.

Science and technology have altered the living conditions of all of us, and the highest goal of research in these fields is toward improving the welfare of all human beings. In this oldest and basic of all industries, we must continue to recognize the necessity of maintaining close relationship between the scientist and the artisan. Through our individual and committee efforts, we must stimulate a greater pride of achievement in all who are connected with the making of castings, from management down to the boy whom we seek to inspire with a desire to select foundry work as a career. No other branch of industry excels our own in opportunities for young men.

From the laboratories of our foundries and colleges, from our committee meetings and chapter meetings, and from our close association with allied industries will come the experiments and discoveries of processes and methods which, when coordinated through the publications and activities of your society, should provide mutual benefits to its membership and to the Foundry Industry as a whole.

As your incoming President, my only ambitions are to carry on the programs so well thought out by those preceding me, and to see that A.F.A. services to you members meet your demands, insofar as it is possible to do so. Only thus can appreciation be properly shown for the honor and trust you have bestowed in calling upon me to serve as your President.

Fred J. Walls

FRED J. WALLS, *President*
American Foundrymen's Association

FRED J. WALLS, International Nickel Co., New York, Manager of the Detroit Office, Development and Research Division, is President of the American Foundrymen's Association, Inc. Mr. Walls has devoted his entire business career to the foundry industry. He attended University of Michigan, Ann Arbor, Mich., where he specialized in metallurgy. He was Vice-President of the Association, 1944-45, served on the A.F.A. Board of Directors for 3 years, 1939-42, has been an active member of numerous A.F.A. Gray Iron Division committees.

Presents the

1945

ANNUAL BUSINESS MEETING OF A.F.A.

Election of National Officers and Directors, presentation of Medal Awards and Life Memberships, 1945 Foundation Lecture, Apprentice Contest results, feature meeting.

CALLING together the men who direct the national and local affairs of A.F.A. and its Chapters, your Association staged a 3-day "Administration Congress" at Chicago's Palmer House, July 17-19, in lieu of the 1945 Foundry Congress. With attendance on an invitational and delegate basis, practically all National Officers and Directors were present, with 30 Chapters represented.

The meetings were held in accordance with ODT regulations, limiting out-of-town attendance at any single meeting to 50. Nevertheless, the entire program was pronounced a complete success, and one that can be expected to advance materially the service of the Association to the membership.

Convening the morning of Tuesday, July 17, the 2nd Annual Chapter Chairman Conference continued throughout the day until noon the following day. After a joint luncheon between the Chapter officers and the National Directors, the afternoon was given over to the Annual Meeting of the 1944-45 Board, the 1945-46 Board meeting the next day.

Annual Business Meeting

The Annual Business Meeting of A.F.A. was held as a dinner meeting the evening of Wednesday, July 18, with over 200 served. Ralph J. Teetor, Cadillac Malleable Iron Co., Cadillac, Mich., presided as retiring President of A.F.A., his audience including many members of the Chicago Chapter and nearby areas.

President Teetor opened the program by introducing the National Officers and guests at the speakers' table, which included Past Presidents Thos. G. Hammond, Whiting Corp., Harvey, Ill.; Duncan P. Forbes, Gunite Foundries Corp., Rockford, Ill.; H. Bornstein, Deere & Co., Moline, Ill., and H. S. Simpson, National Engineering Co., Chicago. Delegates to the Chapter Chairman Conference also were introduced.

In presenting his Annual Message, President Teetor recounted some major activities of A.F.A. during the past year, including a new all-high membership total, formation of the Technical Development Program, initiation of a "Year-'Round Foundry Congress" in lieu of the 1945 convention, and issuance of AMERICAN FOUNDRYMAN in new form. He

Looking toward the speakers' table at the Annual Business Meeting of A.F.A., at the Palmer House, Chicago, July 18. President Ralph J. Teetor presided at the dinner meeting, held in lieu of the 1945 Annual Convention.

stressed particularly the need for greater unity in the objectives of all groups serving the castings industry. His complete message will be found elsewhere in this issue.

Election of Officers

A.F.A. by-laws provide that a slate of National Officers and Directors shall be prepared and announced by a Nominating Committee appointed from lists of names submitted by the Chapters. This slate of nominees was published to the membership in the March issue of AMERICAN FOUNDRYMAN. The by-laws also provide that, if no other candidates are nominated by the membership within 45 days of the Annual Business Meeting, the nominees thus selected shall be declared elected.

Accordingly, Secretary Kennedy read the slate of Officers and Directors thus nominated, and cast a unanimous ballot on behalf of the A.F.A. membership declaring the following duly elected:

President (to serve one year)—Fred J. Walls, Metallurgist, International Nickel Co., Detroit.

Vice-President (to serve one year)—S. V. Wood, President and General Manager, Minneapolis Electric Steel Castings Co., Minneapolis.

Director (to serve one year)—Ralph J. Teetor, retiring President.

Directors (each to serve three years):

George K. Dreher, Vice-President in Charge of Manufacturing, Ampco Metal Inc., Milwaukee.

E. W. Horlebein, President, Gibson & Kirk Co., Baltimore, Md.

Harold H. Judson, Foundry Superintendent, Goulds Pumps, Inc., Seneca Falls, N. Y.

James H. Smith, Assistant to Vice-President, Accessories Group, General Motors Corp., Detroit.

F. M. Wittlinger, Secretary, Texas Electric Steel Casting Co., Houston, Texas.

Guest Speaker

As a fitting climax to the Annual Business Meeting, a thought-provoking talk on "Castings and Post-War Industry" was made by National Director Max Kuniansky, Vice-President and General Manager, Lynchburg Foundry Co., Lynchburg, Va. Mr. Kuniansky emphasized the fact that technical and practical improvements in castings production have exceeded the industry's accomplishments in the way of public and personnel relations. In a competitive post-war period, he said, foundry management must give more thought to its manpower sources, by making definite efforts to present foundry work as a field of unlimited opportunities and interest.

In his response as the newly elected President of A.F.A., Mr. Walls said:

"We are on the threshold of changes in the Arts and Sciences of Founding which, in a large measure, have been brought about by the spread of knowledge and the results of the research within the membership of our association.

"The common basis for our future efforts lies in the two things with which we deal, materials and human beings. The time has come when we must appreciate that the limitations of human beings are just as important to the Foundry Industry as the limitations of the materials and the forces we use in our work.

Clarence E. Sims

Max Kuniansky

Admiral A. H. Van Keuren

M. J. Gregory

Robert E. Kennedy

Doing this, I am convinced we will be able to make the corrections such an appreciation will suggest and, as a result, win the respect, in both the Social and Industrial world, we have earned and deserve."

Presentation of Awards

A highlight of the program was the presentation of two Gold Medals and three Honorary Life Memberships to men who have performed signal service to the industry. The John A. Penton Gold Medal of A.F.A. was presented to Clarence Edgar Sims, Supervising Metallurgist of Battelle Memorial Institute, Columbus, Ohio, *"for outstanding contributions to the steel casting industry."* Presentation was made by National Director L. C. Wilson, Reading Steel Casting Div., American Chain & Cable Co., Reading, Pa., as Chairman of the Board of Awards.

(Concluded on page 92)

ANNUAL MEETINGS of BOARD OF DIRECTORS

National Directors review year's activities in membership, Chapter, publishing, financial work, and Technical Development. Lay plans for strengthening the Association.

President Fred J. Walls

NATIONAL Officers and Directors of A.F.A. held their two-day Annual Meetings, July 18 and 19, at the Palmer House, Chicago, to review accomplishments of the past year and formulate a program for increasing the Association's usefulness to the membership.

R. J. Teetor presided the first day as the retiring President, turning over the gavel on the second day to incoming President Fred J. Walls. This action marked the close of a year during which the Board faced and met many problems of an unusual nature, taking actions that may be expected to broaden and improve the work of A.F.A.

New Membership High

The sustained and enthusiastic work of the membership committees of A.F.A. Chapters, reported by F. J. Walls as Chairman of the National Membership Committee, resulted in another all-time high of 7,815 members. On June 30, 1944, the total was 6,620; two years ago, 5,665; and three years ago, 5,047—a total of 2,765 new members added in a period of three years.

During the 12 months ended June

Director H. H. Judson

Director James H. Smith

Director G. K. Dreher

Director E. W. Horlebein

30, 1945, a total of 1,195 new members joined the Association, including 70 Sustaining, 100 Company and 1,025 Personal members. These increases not only show a more pronounced demand for A.F.A. service, but also impose upon the Association definite obligations for adding to existing facilities and information.

Technical Program

An extensive report on Technical Development Program activities during its first year of operation was presented by N. F. Hindle, Director, covering publications, research, library and educational work. He outlined the work being done with various schools and colleges, books published by the Program, data furnished other publications on foundry subjects, and research work pending and in progress.

Announcement was made of the following T.D.P. publications issued during the past year: 1944 edition of the Cast Metals Handbook; 5th edition of the Sand Testing Handbook; a fourth Malleable Iron Symposium, on Gating and Heading Practices; a Symposium on Centrifugal Castings, the first of its kind; and the 1945 Foundation Lecture by H. A. Schwartz on "Solidification of Metals." Other important publications now are well under way.

Treasurer C. E. Hoyt reported on the support given the Technical Development Program by the industry, indicating a growing appreciation of work accomplished and future possibilities. It is expected that the goal of $250,000 needed for continuous financing of T.D.P. may be reached by the end of 1945.

Chapter Contacts

The report of Director I. R. Wagner as Chairman of the Chapter Contacts Committee, emphasized the progress of the past year in establishing closer relations between the Chapters and the national organization. The first Chapter Chairman Conference, held last August, proved completely successful and was reflected in numerous Chapter activities. As a result, the conference undoubtedly will be held annually.

During the past year, every Chapter was visited at least once by National Officers or members of the Headquarters Staff, bringing about a clearer understanding of national aims and Chapter policies.

Four new Chapters of A.F.A. were organized successfully during the year 1944-45, as announced at the Board meetings. Fine initial support has been given the new Central Ohio, Oregon, Saginaw and Northwestern Pennsylvania Chapters. Several other Chapter possibilities are being considered in areas where considerable interest has been shown, and may be announced during the coming year.

Publication Policies

As Chairman of the American Foundryman Policy Committee, Director D. P. Forbes reported on steps leading up to inauguration of the magazine in expanded and more interesting form. The reaction of members to date has been most favorable, indicating that the publication in its new form is being more widely read than ever before.

Death of H. D. Miles

Expressing the sorrow of the Board over the death of past President H. D. Miles, Buffalo Foundry & Machine Co., Buffalo, N. Y., C. E. Hoyt was instructed as the Alumni Secretary to prepare a suitable resolution that can be spread on the Minutes of the Board and for transmission to the bereaved family. Mr. Miles served the Association as President in 1912-13.

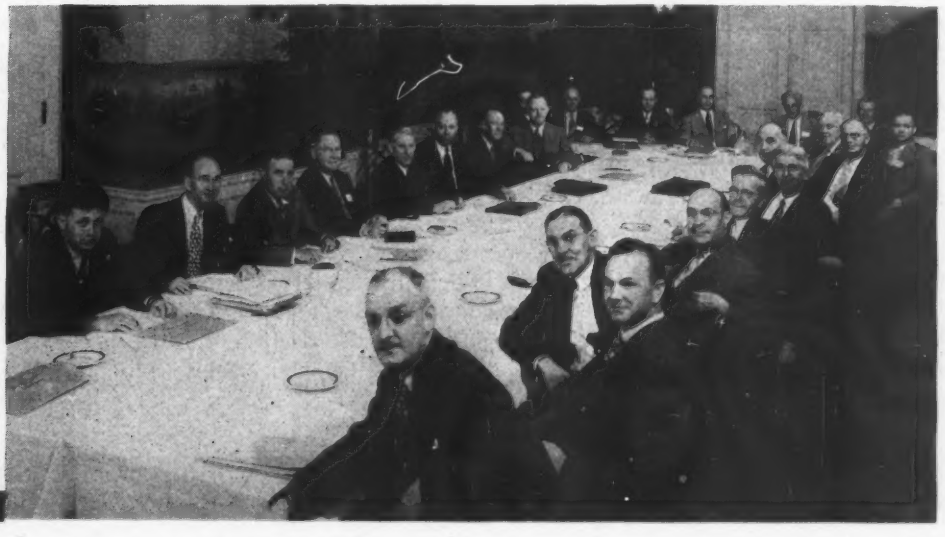
Special Reports

Additional funds were voted for carrying on two important research projects under the Technical Development Program, dealing with the transfer of heat within molds, and the effects of elevated temperatures on sand properties.

Financial reports for the year

Vice-President S. V. Wood

Director F. M. Wittlinger



National Officers and Directors, and members of the Headquarters Staff, assembled in Chicago, July 18, for the Annual Board Meetings. In spite of existing travel conditions, practically all Directors were present to help formulate A.F.A. policies for the coming year.

1944-45 were submitted in combined form, covering operations of both T.D.P. and general activities of the Association. The Auditor's statement showed the financial condition of A.F.A. to be entirely sound and flexible for broader activities. Commenting on these reports, the Directors expressed approval of the policy of operating the Association on a completely and continuously self-sustaining basis.

Executive Committee

At the July 19 meeting, President Walls announced that the 1945-46 Executive Committee would include the following members, to serve with the President, Vice-President S. V. Wood and immediate past President R. J. Teetor: W. B. Wallis, Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa.; L. C. Wilson, Reading Steel Casting Div., American Chain & Cable Co., Reading, Pa.; and James H. Smith, Accessories Group, General Motors Corp., Detroit.

Staff Reorganization

Actions taken by the Board with reference to Staff appointments, bringing about a partial reorganization of the Headquarters Office, will be found in this issue of AMERICAN FOUNDRYMEN on page 26.

Directors Present

Attending the July 18-19 Board meetings were 20 National Officers and Directors, leading figures in the foundry industry elected by the membership to chart the course for A.F.A. progress. In addition to retiring President R. J. Teetor, all newly elected officers and directors were present—President elect F. J. Walls, Vice-President elect S. V. Wood, and Directors elect G. K. Dreher, E. W. Horlebein, H. H. Judson, James H. Smith, F. M. Wittlinger.

Other Directors who responded to roll call were: J. E. Crown, U. S. Navy Yard, Washington, D. C.; D. P. Forbes, Gunite Foundries Corp., Rockford, Ill.; R. M. Jacobs, Stand-

(Concluded on page 29)

2nd ANNUAL CHAPTER CHAIRMAN CONFERENCE

Enthusiastic group discusses problems of Chapter programs, membership work, and coordination with A.F.A. activities.

SOME 32 Chapter officers, directors and delegates gathered in the Palmer House, Chicago, July 17-18, for the 2nd Annual Chapter Chairman Conference, to discuss the coordination of national and local activities. Once again, following the first conference held last August, the event proved a pronounced success, with several Chapter officers terming the meeting "the best ever held by A.F.A." National Director S. V. Wood presided as Chairman of the 1945-46 Chapter Contact Committee.

Other National Officers who attended included: A.F.A. President R. J. Teetor, A.F.A. Vice-President F. J. Walls, National Directors R. T. Rycroft, I. R. Wagner, W. B. Wallis, and L. C. Wilson.

Guests included: R. L. Lee, General Motors Corp., Detroit, guest speaker at the Conference dinner, July 17; Frank G. Steinebach, *The Foundry,* Cleveland; F. G. Sefing, International Nickel Co., New York, as Chairman of the Committee on Cooperation with Engineering Schools; J. W. Wheeler, consultant to Reynolds Metals Co., Springfield, Mass.; Carl W. Wade, Caterpillar Tractor Co., Peoria, Ill.

29 Chapters Represented

All but one of the 30 active Chapters of A.F.A. were represented at the meeting. Chairman of the Chesapeake Chapter, H. F. Taylor, Naval Research Laboratory, Washington, D. C., was prevented from coming by illness. Three Chapters (Michiana, Toledo, Wisconsin) sent additional delegates at their own expense in order to benefit from the discussions. Chapter officers who attended were:

Birmingham—Chairman J. A. Woody, American Cast Iron Pipe Co., Birmingham, Ala.
Canton—Chairman H. G. Robertson, American Steel Foundries, Alliance, Ohio.
Central Indiana—Chairman Ray S. Davis, National Malleable & Steel Castings Co., Indianapolis.
Central New York—H. H. Judson, Goulds Pumps, Inc., Seneca Falls, N. Y.
Central Ohio—Chairman T. E. Barlow, Battelle Memorial Institute, Columbus, Ohio.
Chicago—E. R. Young, Climax Molybdenum Co., Chicago.
Cincinnati—Chairman A. W. Schneble, Advance Foundry Co., Dayton, Ohio.
Detroit—Chairman E. C. Hoenicke, Eaton Mfg. Co., Detroit.
Eastern Canada & Newfoundland—Vice-Chairman Henri Louette, Warden King, Ltd., Montreal, Que.
Metropolitan—Chairman Horace A. Deane, American Brake Shoe Co., New York.
Michiana—Chairman W. V. Johnson, Oliver Farm Equipment Co., South Bend, Ind. Secretary-Treasurer V. S. Spears, American Foundry Equipment Co., Mishawaka, Ind.
Northeastern Ohio—President A. C. Denison, Fulton Foundry & Machine Co., Cleveland.
Northern California—President Chas. Hoehn, Jr., Enterprise Engine & Foundry Co., San Francisco.
Northern Illinois & Southern Wisconsin—Chairman John R. Cochran, Sundstrand Machine Tool Co., Rockford, Ill.
Northwestern Pennsylvania—Chairman R. W. Griswold, Jr., Griswold Mfg. Co., Erie, Pa.
Ontario—Chairman T. D. Barnes, Don Barnes Foundry Supplies & Equipment, Hamilton, Ont.
Oregon—Chairman W. R. Pindell, Northwest Stove & Furnace Works, Portland, Ore.
Philadelphia—Chairman John M. Robb, Jr., Hickman, Williams & Co., Philadelphia.
Quad City—Chairman C. E. VonLuhrte, Chicago Retort & Fire Brick Co., Davenport, Iowa.
Rochester—President Walter F. Morton, The Anstice Co., Rochester, N. Y.
Saginaw Valley—Chairman H. G. McMurry, Buick Motor Div., General Motors Corp., Flint, Mich.
St. Louis—Chairman Walter E. Illig, Banner Iron Works, St. Louis.
Southern California—President R. R.

Haley, Advance Aluminum & Brass Co., Los Angeles.

Texas—Chairman E. P. Trout, Lufkin Foundry & Machine Co., Lufkin, Texas.

Toledo — Chairman N. P. Mahoney, Maumee Malleable Castings Co., Toledo, Ohio. Secretary-Treasurer Gerald R. Rusk, Freeman Supply Co., Toledo, Ohio. Director Charles F. Carson, National Supply Co. of Delaware, Toledo, Ohio.

Twin City—Chairman R. C. Wood, Minneapolis Electric Steel Castings Co., Minneapolis.

Western Michigan—Chairman J. Wesley Lee, Challenge Machinery Co., Grand Haven, Mich.

Western New York—Chairman Arthur H. Suckow, Symington-Gould Corp., Depew, N. Y.

Wisconsin—President John Bing, A. P. Green Fire Brick Co., Milwaukee.

When the Conference opened, President R. J. Teetor gave a short talk on the history and organization of A.F.A., recalling some of the events of the past 49 years that have shaped the present activities. He pointed out that the Association's original aims and objectives, to improve the practices and processes of castings production, have never been changed to this day.

Chapter Program Helps

The 2-day Conference opened on July 17, most of the morning being given over to discussion of Chapter programs, and to Chapter organization and operation. Many ideas were advanced on program features, means of inducting technical discussions, the reception of non-member guests, and the value of special events.

The program included a discussion of the best methods for Chapter organization and operation, and the respective fields of A.F.A. and the several foundry trade associations. President Teetor outlined briefly a number of specific subjects which properly come under jurisdiction of A.F.A. and the trade groups.

National Officers and Directors, Chapter Officers and Directors, and guests around the table at the 2nd Annual Chapter Chairman Conference, held July 17-18 in Chicago. The meeting was held as a part of the 1945 "Administration Congress," in order to acquaint incoming Chapter officers with their local problems during the coming year.

Featuring the luncheon session, F. G. Steinebach, editor of *The Foundry*, as Chairman of the Committee on International Relations traced the origin of A.F.A. cooperation with foreign foundry groups in 1919. He announced that several groups, disbanded during the war years, now are becoming more active, leading to the possibility of a resumption of the International Foundry Congress in the near future.

Educational Work

Chapter chairmen showed great interest in the educational activities of A.F.A., discussed the afternoon of the first day. Vice-President Fred Walls covered the scope of the Youth Encouragement Committee, which has for its purpose the encouragement of young men of grade and high school age to consider foundry work as a career.

Secretary Kennedy described the apprentice training activities of A.F.A., dating back to 1897, and told briefly of the local and national apprentice contests sponsored annually. He urged Chapter chairmen to play a more active part in stimulating local interest in these contests, especially when apprentice programs can be revived after the war, during the post-war period.

The new educational lecture courses sponsored by the Southern California and Philadelphia Chapters were described, and considerable discussion followed on types of courses, objectives, and expectations of support by local companies.

F. G. Sefing gave a brief talk on the activities of the Committee on Cooperation with Engineering Schools, and developed a number of ways in which local foundries can assist in this work. He suggested visits by foundry executives, talks before graduating classes, scholarships or fellowships on foundry projects, Chapter visits by students, and the contacting of graduate engineers.

Delegates to the Chapter Chairman Conference take time out from their discussions for luncheon. Exceptional attendance, in spite of existing conditions, showed the interest of Chapter Chairmen in progressively expanding their local activities.

Technical Activities

In describing the technical committee work of A.F.A., Secretary Kennedy stressed the need for "new blood" to serve on the many committees now set up. He asked the

Chapter Chairmen to assist by suggesting the names of promising men, and spoke briefly of the great flow of technical and practical publications which have been developed in committee meetings.

At the dinner meeting, Tuesday night, R. L. Lee of General Motors Corp., gave an inspiring talk on "Leadership," pointing out those qualities of leadership which are recognized by the men in the shop.

The program of July 18 included a discussion of the Technical Development Program of A.F.A., by its Director, N. F. Hindle. Mr. Hindle told of the inception and development of T.D.P., some of its accomplishments during the first year of activity, and its importance to the membership and the industry.

Director L. C. Wilson, as Chairman of the Finance Committee, and Treasurer C. E. Hoyt, gave the chairmen some highlights of A.F.A. financing, and showed how the A.F.A. income dollar is expended on behalf of the industry. This was followed by a discussion on Chapter financing, led by Director I. R. Wagner, especially in relation to the new dues structure effective July 1.

Chapter Membership

Considerable discussion took place on Chapter membership activities, led by Vice-President F. J. Walls as Chairman of the National Membership Committee. Chairman Walls praised the work of the Chapter membership workers, bringing about a new record membership.

Robert E. Kennedy
Secretary Emeritus

National Office Staff Elected by Directors

THE Board of Directors of A.F.A., at their Annual Meetings of July 18-19, approved a partial reorganization of the National Office Staff. Acting on recommedations of the Executive Committee, steps were taken to fulfill those broader functions and responsibilities imposed by the largest membership in the Association's history, and an industry facing severe post-war competition.

Wm. W. Maloney
A.F.A. Secretary

Norman F. Hindle
Director of T.D.P.

Jennie Reininga
Assistant Treasurer

C. E. Hoyt
Treasurer

Secretary Emeritus

One action involved relieving ROBERT E. KENNEDY of his responsibilities as Secretary of A.F.A., and his designation by the Board as Secretary Emeritus, in full recognition of his long and faithful service to the Association, the membership and the industry.

Few men in the foundry field have merited the esteem in which Bob Kennedy is held, because of his unselfish and kindly devotion to committee work, convention programs, Chapter organization and the encouragement of young men in the industry. It is these qualities that richly earned him the Joseph S. Seaman Gold Medal of A.F.A., an award symbolizing "Kindliness," presented to him July 18 at the 1945 Annual Business Meeting.

In according Mr. Kennedy the title of Secretary Emeritus, the Board acted to preserve his usefulness and experience to the Association for the longest period possible, by relieving him of increasing administrative burdens due to expanding activities and obligations. A host of friends will be glad to know that he will continue active in A.F.A. councils, exerting a steadying influence on

Association functions for many years to come.

Secretary

WILLIAM W. MALONEY, formerly Business Manager, was elected Secretary and chief administrative officer of A.F.A. Mr. Maloney's connection with the foundry industry dates back to 1922 when, as a student at the University of Illinois, he served as stenographer to Robert E. Kennedy, then Assistant Secretary of A.F.A. and foundry instructor at the university. After receiving a degree in Business Administration, Mr. Maloney joined the editorial staff of Penton Publishing Co., Cleveland, and in that capacity reported the 1926 International Foundry Congress in Detroit.

Joining the A.F.A. Staff in 1929 as assistant to Technical Secretary R. E. Kennedy, he played an active part in the 1930, 1931 and 1933 conventions and exhibits as a Staff member. From 1935 to 1942 he held the position of Assistant Advertising Manager with the Burlington Railroad and Bus Lines, Chicago. Returning to A.F.A. in February, 1942, he has held, successively, the titles of Staff Assistant, Assistant Secretary and Business Manager, prior to his election as Secretary. Mr. Maloney is known to many A.F.A. members for his work at the 1942, 1943 and 1944 Foundry Congresses and Chapter contacts.

Director of T.D.P.

NORMAN F. HINDLE was reelected Director of the Technical Development Program on July 18. Under his direction, and with the guidance of an Advisory Committee of industry, T.D.P. has become a rapidly growing force in developing technical publications, library facilities and research projects of general interest, and in fostering educational opportunities throughout the castings industry.

Mr. Hindle's technical education (Purdue University), plus a broad practical foundry experience with such castings producers as American Steel Foundries, will be especially valuable in carrying out the basic objectives of A.F.A. as a technical society. Through committee, convention and Chapter work, he is widely known in the industry.

Treasurer

C. E. HOYT, reelected Treasurer, is known throughout America as the "dean of exhibit managers." His management of Foundry Shows since 1908 has been considered a model for the staging of industrial exhibits. Secretary of A.F.A. from 1918 to 1937, and as Executive Vice-President until 1941, Ed Hoyt's sound counsel and advice have long been valuable assets of the Association.

MISS JENNIE REININGA, reelected Assistant Treasurer, has been a "silent partner" at A.F.A. Headquarters since 1918 . . . a tenure of service known to few members today. Her knowledge of general Association activities, particularly in membership work and convention arrangements, has been a prominent factor in A.F.A. administration duties for many years.

MISS FANNIE HALL, an engineering graduate of the University of Minnesota, lends able assistance in the editing and preparation of technical and practical material under the Technical Development Program. Formerly, she served as Technical Secretary, Allison Div. of General Motors Corp., Indianapolis, and in the experimental laboratory of Antioch Foundry, the Delco-Remy Div. of General Motors.

Much of the credit for the improved apperance of AMERICAN FOUNDRYMAN goes to GERALD R. BUHLER, Assistant Editor. Mr. Buhler came to A.F.A. direct from the University of Illinois, and has had considerable experience on A.F.A. publications. After two years of active service with the U. S. Navy as Lieutenant (jg), he returned to the Association when the new AMERICAN FOUNDRYMAN was inaugurated.

C. R. MCNEILL is mainly responsible for the Annual Bound Volume of TRANSACTIONS, and for whipping into publication shape the technical and practical papers submitted to A.F.A. Mr. McNeill came to A.F.A. with a background of practical industrial experience, an essential element in the valuation and preparation of published information for foundrymen.

TERESE B. KOELLER, upon whom A.F.A. largely depends for the advertising content of AMERICAN FOUNDRYMAN, has had considerable experience in editorial sales promotion and trade paper advertising with several national magazines. Prior to joining the National Office Staff, Miss Koeller was associated with such recognized publications as *Popular Mechanics, Modern Advertising, Inland Printer, Circulation Management* and *Automobile and Trailer Travel.*

Fannie Hall

Gerald R. Buhler

C. R. McNeill

Terese B. Koeller

President's Annual Address Calls For Expansion of A.F.A. Services

Presented by retiring President R. J. Teetor before the Annual Business Meeting of A.F.A., July 18.

Ralph J. Teetor
Retiring A.F.A. President

WHEN, in January, the Director of War Mobilization requested that conventions be canceled except those involving distant attendance of less than fifty persons, your Board of Directors was quick to respond and to cancel plans for the 4th War Production Foundry Congress, which had been scheduled for the first week in May and for which extensive preparations had already been completed. Thus the 49th Annual Convention of A.F.A. became a war casualty, but this 49th Annual Business Meeting survived.

Cancelation of the convention necessitated the undoing of many things that had been planned, foremost of which was preparation for the Pre-Convention issue of AMERICAN FOUNDRYMAN. Space had been sold and advertising matter prepared, when it became obvious that a Pre-Convention number without a convention could hardly be justified.

New Magazine Policy

Immediate decisions became necessary. On January 16, the Executive Committee met, and on the following day the Board of Directors. It was unanimously decided to abandon plans for the 49th Annual Convention in Detroit and to adopt a suggestion which had been discussed and urged many times in past years—to include advertising in each issue of AMERICAN FOUNDRYMAN, beginning in May and carrying on during the rest of 1945, and to present a "Year-'Round Foundry Congress," through its pages.

Consequently, you now have the AMERICAN FOUNDRYMAN in its new form. Decision as to whether the policy of continuing its present form after the trial period, has yet to be made.

The constantly improved pages of the AMERICAN FOUNDRYMAN keep our membership more completely informed of the progress of the Association and of the actions of the Board of Directors. The "Report to the Membership," recently sent to all members from the National Office, enumerates the major activities which have been completed or are presently in progress or about to be undertaken.

At this time I wish to mention a few of the accomplishments of A.F.A. which I consider especially noteworthy and as having progressed or been initiated during the past year.

New Membership Record

Membership has again reached an all-time high, standing at 7,815 on June 30, 1945. The significance of this accomplishment is obvious. Your Technical Staff and the General Staff at the National Office, as well as your National Officers and Board of Directors, are fully aware that this increasing interest in the objectives of the Association creates an obligation for the enlargement and amplification of the services which may properly be offered by the Association.

National Membership Chairman Fred Walls and his committee of Chapter membership chairmen are entitled to all the credit for the more than normal increase in membership during the past year.

A committee of the Board was appointed to thoroughly explore the matter of dues from members, and brought in the recommendation that minimum Company Member dues be increased from $25.00 to $50.00 annually, and that Sustaining Membership dues be increased from $50.00 to a minimum of $100.00 annually. No recommendation was made for a change in the dues of Personal Members. The recommendation of this subcommittee was unanimously approved by the Board of Directors in January, and the new dues structure therefore became effective on July 1 of this year.

Four Chapters Added

Expansion of our Chapter Membership by four new Chapters—Central Ohio, Oregon, Saginaw and Northwestern Pennsylvania — is an accomplishment in which your National Officers take great pride. Credit for this outstanding achievement goes three ways: to Secretary Robert E. Kennedy, who has so effectively promoted and encouraged Chapter organization; to the local committees of foundrymen, members of A.F.A. who have assumed the burden of the organizational work; and to the neighboring Chapters who have cooperated so generously and have in some cases given up a portion of their own membership in order that new Chapters in other areas might be established.

Acquisition of the Dr. Richard Moldenke Library of some 500 volumes on foundry practice in America and abroad, the gift of Mrs. Moldenke, constitutes a notable addition to the library of A.F.A., which is now the most complete collection of text books on foundry practice in America. One of the major objectives of the Association, and one of increasing interest and importance, is to expand our technical library and promote its availability to foundry and related interests.

How T.D.P. Began

I want to say a special word here about the Technical Development Program, because, while it has begun to reach sizeable stature during my term of office, it had its conception in the minds of earlier administrations several years back. Definite action was taken toward establishment of an A.F.A. Foundation under the leadership of past President Duncan Forbes, in 1942-43. That administration made no mis-

take when it envisioned a Foundation for the advancement of foundry science, greater in scope and requiring greater financial outlay than has as yet been found possible of fulfillment.

During the succeeding year, 1943-44, your Board of Directors under the leadership of Lee Wilson considered and reconsidered, revamped and reconstructed, and even renamed the project. By the end of that year they had formulated a revised plan, now the Technical Development Program, which gives promise of carrying out the fundamental objectives earlier envisioned, and of growing to the stature originally conceived.

The Technical Development Program has completed its first year of existence under the directorship of Norman F. Hindle. It has taken over the publishing of technical books on foundry practice and has functioned well, within the limits of personnel and time available.

Unlimited Possibilities

It is to be expected that the Technical Development Program, having as its functions the promotion of technical publications, expansion of library facilities and the encouragement of increasing educational opportunities as related to the foundry industry, will make itself felt and increasingly valuable, as the ambitious program which it has undertaken gradually develops. Plans are definitely under way for the expansion of its technical and administrative personnel, necessarily difficult of accomplishment because of conditions arising out of the war.

Technical development activities constitute the most important function of a technical society such as A.F.A., for without expanding technical activities and promotion of technical education opportunities and facilities for the foundry and allied industries, this great Association of ours would take on the color of a social or fraternal organization.

The support that has been given to the financial requirements of the Technical Development Program has been generous. It is to be expected that, as this program expands and is more fully recognized in its true perspective, the membership of A.F.A. and the foundry and allied industries will continue to support it even more liberally.

Relations with Trade Groups

Another field in which A.F.A. offers service to the foundry industry is in cooperation with the several foundry trade associations which serve the various branches — steel, malleable, gray iron, nonferrous. In promoting the commercial advancement and technical progress of the various industries, these trade associations are great constructive forces in the industry; but they are by their very nature separately inspired and functioned.

The foundry industry will present to industrial America a more accurate conception of its basic importance when there is greater unity in the objectives of the various branches. The most wholesome and permanently constructive objective looking toward unity of purpose and deserving of national recognition stands unchanged for 49 years;

> "To promote the arts and sciences applicable to metal castings manufacture. To improve the methods of production and quality of castings."

Within this premise, A.F.A. eagerly solicits every opportunity to be of service to every Trade Association of the foundry or allied industry. The A.F.A. can never divert its energies from this single purpose. It can never assume the general functions of a trade association. It can, however, through the expansion of its membership and through its more comprehensive services to members, promote the unification of the foundry industry and national recognition so well deserved.

Request for Committeemen

Committees for the 1945-46 season are being formulated now by the Secretary, American Foundrymen's Association. These committees are composed of foundry men whose service on A.F.A. committees benefits the industry and reflects honor upon those who give unselfishly of their knowledge. There are over 150 committees dealing with gray iron, malleable, steel, aluminum and magnesium, brass and bronze and committees of general interest from which to choose. If you desire to serve on a committee, name your preference and address your letter to: Secretary, American Foundrymen's Association, 222 W. Adams St., Chicago.

A Mandate for Service

A technical society whose membership has expanded from 2,500 to 7,800 in the space of eleven years, and whose increment of increase has quite generally been greater year by year (1,195 in the last twelve months), surely has received a mandate to expand its services.

Now in closing, I wish to say a word of appreciation to the staff at the National Headquarters. The servicing of our greatly increased membership, our expanded roster of chapters, now numbering 31, and the promotion of activities under the Technical Development Program has been accomplished through the fine and loyal efforts of the staff organization.

As my term of office comes to an end with this meeting, I find it impossible to adequately express my appreciation to the many committees of the Association for their splendid work throughout the year, to those authors who have prepared the papers now being published in the AMERICAN FOUNDRYMAN in lieu of the Convention, to the Directors, and especially to the members of the Executive Committee for their fine support and cooperation.

My principal regret is that I found it utterly impossible to take advantage of the privilege of visiting many of the Chapters during my term of office. Such visits as I could and did make were inspiring to me and will always remain among my most pleasant memories. I deeply appreciate the honor of having been called upon to serve.

ANNUAL BOARD MEETING

(Continued from page 24)

ard Brass Works, Milwaukee; Max Kuniansky, Lynchburg Foundry Co., Lynchburg, Va.; S. D. Russell, Phoenix Iron Works, Oakland, Calif.; R. T. Rycroft, Jewell Alloy & Malleable Co., Buffalo, N. Y.; H. S. Simpson, National Engineering Co., Chicago; Joseph Sully, Sully Brass Foundry Ltd., Toronto, Ont.; I. R. Wagner, Electric Steel Castings Co., Indianapolis; W. B. Wallis; L. C. Wilson; W. L. Woody, National Malleable & Steel Castings Co., Cleveland.

GAMMA RAY RADIOGRAPHY

Its Advantages and Disadvantages

By R. A. Gezelius, Chief Metallurgist,

General Steel Castings Corp.,

Eddystone, Pa.

THE subject of non-destructive testing of castings has received considerable attention in recent years, and no doubt will receive even more in the future. In fact, the increasingly more rigid specifications for castings will guarantee an increasing interest. These more rigid specifications will lead to the production of better castings, free from internal defects.

There is no doubt that specification requirements will be more strict as time goes on. During the present war, the War and Navy Departments have converted many forged parts to castings in order to utilize the full productive capacity of the country. These converted parts have been studied carefully. The standards of acceptance have been high. However, the foundry industry has been able to produce the required material.

Many of the articles which have been produced as castings for the war effort are in the "restricted" class and, therefore, the specifications employed and the results obtained have not become common knowledge. However, it is only a question of time until the armed services will demand the same degree of perfection in all castings produced for them.

Commercial purchasers will then, in turn, demand comparable castings for their use. In view of these facts, it is now more important than ever that foundrymen employ the non-destructive tests available to them as tools to evaluate and perfect their own product.

One of the non-destructive tests which is available to foundrymen is radiography by the use of gamma rays. Mehl, Doan and Barrett,* in 1930, showed the possible use of gamma rays for the detection of defects in metals. Since that time many papers have been published, in which every phase of the techniques of making, developing and interpreting radiographs has been discussed.

In addition, standards of acceptance for various items have been prepared and are in use by at least two government agencies. Some commercial consumers also use these standards, or variations of them, as their standards of acceptance. These data are all available in the technical literature, so there is no point in reviewing the information here.

Radiographic Process

For the purposes of this discussion, the radiographic process can be simply explained as the production of shadowgraphs which indicate the comparative densities of various portions of the article being examined. The entire process can be visualized by comparing it to the production of a print from an ordinary photographic negative, a process familiar to everyone.

For this purpose, we may assume that the photographic negative is the part to be examined. On this negative the clear areas will represent actual voids, the light gray areas will represent areas of low density such as sand or slag inclusions or porous or spongy areas, the darker gray areas will represent solid metal and the black areas protrusions on the casting.

In the photographic printing process, the negative is placed adjacent to a piece of sensitized photographic paper, between the paper and a source of light. The light rays pass through the negative and are recorded on the sensitized paper. The sensitized paper will be blackened in varying degrees, depending upon the amount of light absorbed by various areas.

The areas adjacent to clear areas on the film will be very black, as the negative has permitted all light to pass at this point. The areas adjacent to dark areas on the negative will be very light in color, as the negative has permitted little or no light to pass at this point. This process is identical with the radiographic process except that in radiography the light source is short wave length invisible light such as x-rays or gamma rays.

These light rays are absorbed by a metal mass of varying density, and the sensitized paper is replaced by a sensitized radiographic film. The result, in radiography, is a

• Radiographic inspection is among the tools employed by the foundryman to evaluate his product and to assure its perfection. The rigid specifications and high acceptance standards for wartime products — which the foundryman has met successfully—will be demanded for postwar products, and the foundryman has available the tools to meet these demands.

*R. F. Mehl, G. E. Doan, and C. S. Barrett, "Radiography by the Use of Gamma Rays," *Transactions*, American Society for Steel Treating, vol. 18, p. 1192 (1930).

shadowgraph which indicates the comparative densities of the part inspected by the degree of blackening obtained on the film.

As the interest in radiography has increased, more attention has been paid to the advantages or disadvantages of x-ray and gamma ray inspection. There have been many discussions which have attempted to indicate that one of these sources of radiation is definitely superior to the other. This attitude has led to considerable confusion, as each of these sources of radiation had advantages and disadvantages not possessed by the other.

Inspection Method Selection

Each of these methods of radiography has certain fields of inspection for which it is definitely superior. There is, of course, some overlapping of these fields of inspection, but the two methods of inspection should be considered as complementing each other rather than as competitors.

Radiography, whether conducted by x-rays or gamma rays, has a decided advantage as a method of inspection in that it is possible to determine the degree of soundness of a casting without destroying the casting itself. This is extremely important in the production of large castings, where tests by destruction would be both expensive and time consuming. On castings of these types, the method can be also used to prove the acceptability of any welding repairs which may be required as a result of either visual or radiographic inspection.

While radiography has decided advantages as an inspection medium, it also has its limitations and cannot be relied upon to disclose every defect in the part examined. The difference in density between a sound area and an area containing a defect must be sufficiently great to cause a change in the degree of blackening on film sufficient to be noted by the eye.

The change in density required for this will depend upon the density and thickness of the material inspected, the wave length of the radiation used and the technique employed. On thin sections of the light alloys, extremely small defects may be located with long wave length radiation. However, on steel, bronze or the other heavier alloys, with the shorter wave lengths required to penetrate this material, a change in density of 1½ to 2 per cent is required.

Thus, a single defect with a dimension of less than 1½ to 2 per cent of the total thickness of the piece being examined will not be disclosed. All defects with dimensions greater than this will be revealed. It is obvious that radiography cannot be expected to disclose fine cracks, for example, unless the depth of the crack is in line with the rays passing through the piece.

All of the foregoing applies to radiography generally. Radiography with gamma rays has certain advantages and disadvantages which are peculiar to it. All of these advantages are dependent upon two physical facts; (1) the method by which the rays are produced and (2) the wave length of the rays themselves. These advantages and disadvantages may be tabulated as follows:

Source of Radiation

Advantages
- Portability
- Simplicity of Operation
- Constant Activity

Disadvantages
- Constant Wave Length
- Constant Intensity

Wave Length

Advantages
- Good Penetration
- Less Scattering

Disadvantages
- Less Contrast
- Slower Speed

These advantages and disadvantages will be discussed in detail in the following paragraphs.

Radiation Source

X-rays are a man-made source of radiation and, therefore, a wide choice of wave lengths and intensities are available in the initial choice of equipment. Each particular x-ray is limited in wave length variations, but the intensity of the ray may be varied considerably.

Gamma rays are a product of nature. They are produced by the dissociation of radium. Radium decomposes at a constant rate into the gas radium emanation, which, in turn, produces a series of decomposing solids, some of which give off gamma rays. Radium is prepared for industrial radiography by placing a known amount of a radium salt in an hermetically sealed silver container.

The radium salt placed in this container decomposes, forming radium emanation which builds up until equilibrium is reached, when the rate of decay is equal to the rate of formation. After equilibrium has been attained, the strength, or intensity, of the radiation given off is proportional to the amount of radium present.

The wave length of gamma rays cannot be varied, as is the case with x-rays. The intensity can be varied only by increasing or decreasing the amount of radium present in the sealed cylinder. The intensities available in these sealed cylinders vary from those which contain 25 milligrams of radium to those which contain as much as 500 milligrams.

Gamma Ray Emission

The 25-milligram capsule is a sphere approximately 3 millimeters in diameter. The largest capsules are cylinders approximately 10 millimeters in diameter and 7 millimeters high. In industrial work, these small silver capsules are protected from damage by being enclosed in an aluminum "egg" to which cords are attached to facilitate handling.

The decomposition of radium is a continuous process. Gamma rays are thus emitted continuously. When not in use the capsule is usually stored in a portable lead-lined case, which absorbs most of the gamma rays produced. The material may be transported safely in these lead-lined cases, which are supplied with the radium pellet.

The small size of the radium pellets leads to one of the principal advantages of gamma-ray radiography, portability. The source of radiation in its lead-lined container is sufficiently small and light to be transported readily to any piece which is to be inspected.

In addition, the source of radiation is itself so small that it can be attached to the end of a rod and inserted in a narrow opening, or pulled into place by the cords attached to its aluminum container.

This extremely portable source of radiation has permitted radiographic examinations of many articles which could not be inspected by any other method. For instance, the sternpost of a ship has been radiographed while the ship was moored to its pier.

Inspection was carried out by tack welding a tripod support to the outside of the sternpost to sup-

port the radium capsule. The films were placed on the inside of the sternpost. The source of radiation, the sternpost and the films were thus always in the same relative position and not affected by the rolling of the ship.

The ship was in port for only a few days and, as the proper type of electric power was not available, this casting could not have been inspected with x-rays within the time allotted, even if the proper support for the x-ray equipment were attached to the side of the ship.

Large Casting Inspection

In the larger jobbing foundries, there are many large castings which can be inspected easily with gamma rays, without positioning, which would be difficult to handle with x-ray equipment.

The ease of manipulating the source of radiation itself has permitted the examination of enclosed box sections, deep pockets in castings, the joints in long lengths of welded pipe, etc., many of which cannot be reached with an x-ray tube and are too small or too difficult to reach for the proper placement of films on the inside of the section.

Another advantage of gamma ray radiography associated with the method by which the rays are produced is the simplicity of conducting gamma ray inspections. A definite intensity of radiation is always available with each radium capsule. The operator merely has to place the pellet and film in their proper locations and time the exposure correctly.

Timing Exposure

Slide rules and charts are available to assist one in these simple calculations. As the source of radiation is continuous, the exposure may be adjusted to run overnight or over the week-end by a proper selection of the film-to-source distance. It is not necessary for an operator to be present to watch or control the process of radiographic inspection.

The principal disadvantage of gamma ray radiography, due to the manner in which the rays are produced, is the inability to change the wave length of the radiation produced. The wave lengths of gamma rays are comparatively short, and are considered comparable to those which would be produced by a two and one-half million x-ray tube.

The wave length of the radiation employed in radiography has a large bearing upon the results obtained. Long wave length x-rays, which are produced in x-ray tubes with a comparatively low potential, are easily absorbed by solid masses. They, therefore, cannot penetrate great thicknesses or material of a high density. However, they are easily recorded on a photographic film.

This ease of recording, plus the fact that a slight change in density will cause a comparatively large change in the amount of radiation absorbed while the ray is passing through the piece being inspected, results in extremely good contrast in the radiograph obtained. On light alloys and thin sections, the best results are obtained with equipment of this type.

All radiation passing through a test piece creates within the piece secondary radiation of a wave length longer than that of the primary ray. This is known as "scattering." This secondary or scattered radiation is also recorded by the photographic film. As the scattered radiation has a longer wave length than the primary ray, it is recorded by the film even more readily than is the primary ray.

This paper was secured as part of the 1945 "Year-'Round Foundry Congress" and is sponsored by the Steel Division of A.F.A.

As the thickness of the test piece increases, the amount of the primary ray reaching the film decreases, but the amount of the secondary radiation increases until the secondary radiation will cover over any image produced by the primary ray unless special precautions are taken. Therefore, as the density or the thickness of the material to be radiographed increases, it is necessary to use rays of greater penetrating power to decrease the difficulties due to scattering.

Greater penetrating power is obtained by using rays with shorter wave lengths which, fortunately, scatter less. The secondary radiation produced also has a shorter wave length, and thus difficulties due to scattering are decreased.

As the wave length of the ray is decreased, the ease with which the rays are recorded on the film is also decreased. The change in the amount of radiation absorbed by slight changes in density is not as great as with longer wave lengths, and thus, while difficulties due to scattering are reduced, the contrast of the finished negative is also reduced.

As the wave lengths of gamma rays cannot be changed, and they are comparatively short, they are not suitable for all types of radiography. They are not as satisfactory for thin sections or for light alloys as are the longer wave length x-rays. Good results are obtained on the heavier alloys in sections of over ½-in. thickness.

The short wave length of gamma rays reduces the difficulties due to scattering to the point where artificial methods of control are not required. However, there is some loss in contrast, and this should be considered when comparing radiographs produced with gamma rays and with x-rays of longer wave length. In addition, these short wave length gamma rays have excellent penetrating ability, and can be used to radiograph sections which can be penetrated only by the largest x-ray machines.

Radiation Intensity

The intensity of the radiation produced by radium is not as great as that produced artificially by the x-ray tube. Gamma ray radiography is, therefore, slower than radiography with x-rays when the time required to produce one radiograph is considered.

Gamma rays are emitted from the capsule in all directions, and many times it is possible to produce several radiographs simultaneously. In these cases, the overall time required to radiograph an entire object, or several objects, may compare very favorably with that required when x-rays are used.

Gamma ray radiography has an additional advantage for jobbing foundries which employ radiography only occasionally. Radium capsules of various sizes are available on a rental basis. Gamma ray inspections can, therefore, be conducted without large capital expenditures.

APPRENTICE CONTEST

Winners Announced at Chicago Congress

THE annual competition in gray iron, steel and non-ferrous molding and patternmaking, sponsored each year by the A.F.A. Apprentice Training committee, was held in Chicago, Saturday, July 14. Each year, since the first competition was started at the Milwaukee convention in 1924, the competitive spirit has become keener. However, this year, due to wartime conditions, the number of participants has decreased although quality and workmanship has increased.

Though the judging was conducted in the National Association's offices, the apprentice contest castings and patterns were on display at the Palmer House, Chicago, during the Administration Congress. They were viewed with intense interest by those members who attended the Congress.

Winners in the 1945 contest are:

Non-ferrous Molding

First — John Hronek, Wisconsin Aluminum Foundry Co., Manitowoc, Wis.

Second — Frank Spano, Allis Chalmers Mfg. Co., Milwaukee.

Third — John Chrnelich, Allis Chalmers Mfg. Co., Milwaukee.

Gray Iron Molding

First—E. Doucet, Canadian National Railways, Montreal, Quebec, Canada.

Second—Steve Grabowski, Cleveland Trade School, Cleveland.

Third — H. Lalonde, Montreal Foundry, Ltd., Montreal, Quebec.

Steel Molding

First — Frederick C. Krueger, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

Second — P. Crevier, Canadian Car & Foundry Co., Ltd., Montreal, Quebec, Canada.

(Only two entries.)

Patternmaking

First — Anthony Taddeo, Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

Second—Robert Cech, Cleveland Trade School, Cleveland.

Third—D. MacKenzie, Canadian National Railways, Montreal, Quebec, Canada.

Names of men who acted as judges of the various contests and to whom the Association wishes to extend its sincere thanks for their excellent co-operation are as follows:

Patternmaking

R. W. Schroeder, Washburne Trade School, Chicago.

Martin Rintz, Continental Foundry & Machine Co., East Chicago, Ind.

H. K. Swanson, Swanson Pattern & Model Works, Chicago.

Frank Mueller, American Steel Foundries, Indiana Harbor Works, Indiana Harbor, Ind.

Steel Molding

Martin Rintz, Continental Foundry & Machine Co., East Chicago, Ind.

Frank Mueller, American Steel Foundries, Indiana Harbor Works, Indiana Harbor, Ind.

Gray Iron Molding

R. W. Schroeder, Washburne Trade School, Chicago.

C. G. Mate, Greenlee Foundry Co., Chicago.

F. H. Peterson, Northwestern Institute of Technology, Evanston, Ill.

Non-ferrous Molding

R. W. Schroeder, Washburne Trade School, Chicago.

John M. Sheridan, Crane Co., Chicago.

The Association is gratified that the Apprentice Training committee, under the chairmanship of Carl W. Wade, Caterpillar Tractor Co., Peoria, Ill., was able to conduct the contest this year under conditions which were quite difficult because of the war. The Association is looking forward to more and more chapters sponsoring contests.

Judging the 1945 Apprentice Contest entries at the National Office. Top (left to right)—Molding Judges Martin Rintz, Frank Mueller, R. W. Schroeder, J. M. Sheridan, C. G. Mate and F. H. Peterson pick the molding contest winners. Carl Wade (extreme right), Chairman, Apprentice Training Committee, watches the judging. Bottom—The same group, with H. K. Swanson (second from left) pick the victors in the pattern division.

Grain Refinement of MAGNESIUM CASTING ALLOYS

By James A. Davis, Research Engineer, L. W. Eastwood, Assistant Supervisor, and James DeHaven, Research Engineer, Battelle Memorial Institute, Columbus, Ohio.

METALLURGISTS, in recent years, have become increasingly aware of the importance of grain size as a factor determining the useful characteristics of metal products. Grain size control can be applied whenever new grains are formed or old ones grow during manufacture.

Usually such grains may form or grow either (1) from a solid such as by an allotropic transformation or by recrystallization and grain growth when annealing worked materials, or (2) from a liquid melt during the process of solidification.

The application of grain size control of new grain formation or growth in a solid has been utilized for a longer time and with greater general success than the application of grain size control methods to the formation of new grains during solidification.

Indeed, many alloys of various base materials are cast today in many foundries without any attempt at grain size control. The light alloy foundries are outstanding in their efforts to control the cast grain size, and thereby control one of the factors which affects the quality and usefulness of their product.

The importance of grain size control in a magnesium foundry is well illustrated by the work of Achenbach, Nipper, and Piwowarski[1] on the relationship of grain size and foundry characteristics. A recent paper by Busk and Phillips[2] reports a systematic investigation on the relationship of grain size of ASTM-4 and ASTM-17 alloys to the various mechanical properties.

Hot Shortness

The foundry characteristic most affected by grain size is hot shortness. While the magnesium alloys are not particularly hot short, they are quite frequently subjected to considerable strain after casting and while the metal is cooling in the mold.

Magnesium melts have low specific heat by weight and are poured at relatively low temperatures. Because of these two factors and the usual thin sections, internal cores do not collapse readily, with the result that considerable strain is produced in the hot castings.

It is quite well known that epidemics of hot cracks in a magnesium foundry are quite frequently associated with poor grain refinement.

The effect of grain size on the mechanical properties is quite marked. According to Busk and Phillips,[2] an increase in grain size from 0.004 in. to 0.015 in. has the effects upon various mechanical properties of sand cast test bars shown in Table 1.

In addition to the adverse effects of increased grain size previously cited, there is some evidence that an increase in grain size interferes with the solution heat treatment, making a longer time at the solution temperature necessary.

The cause of this interference is probably twofold: (1) the particle size of the beta constituent tends to increase with an increasing grain size; (2) the larger grain produces a greater distance for diffusion because the beta particles are generally concentrated at the grain boundary, and this soluble constituent at the periphery must diffuse into the grain. There is also some evidence that an increase in grain size increases the quantity and augments the deleterious effect of grain boundary unsoundness such as microporosity.

There are factors, such as the degree of microporosity and perhaps the quality of the heat treatment, which are more important and have a greater bearing upon the quality

• ***As part of the general program sponsored by the Office of Production Research and Development of the War Production Board, and under the guidance of the Office of Scientific Research and Development, this paper describes a method of obtaining grain refinement in magnesium alloy melts which have been degassed and cleaned by methods developed under another part of the program. In general, grain refinement of magnesium alloys containing aluminum may be obtained by treatment with carbonaceous materials.***

of the casting than its grain size. However, the available information definitely indicates that grain size control in magnesium castings is an essential feature of high quality.

It should be noted that it is quite possible to obtain too much grain refinement because such fine-grained castings, especially with high aluminum content, will germinate and produce very large grains up to ½ inch in diameter, or even greater, during the heat treatment. When such germination occurs, the mechanical properties are very low.

Such excessively fine grains are usually obtained by the combination of otherwise acceptable grain refinement with too rapid solidification, as in those parts of castings adjacent to chills or in thin fins.

Table 1[2]

EFFECT OF GRAIN SIZE INCREASE (0.004 TO 0.015 IN.) ON MECHANICAL PROPERTIES OF MAGNESIUM SAND CAST TEST BARS

	Reduction in Properties, per cent		
Property	*Heat Treated ASTM-4**	*Heat Treated and Aged ASTM-4**	*Heat Treated and Aged ASTM-17**
Tensile strength, psi.	12	12	12
Elongation, per cent in 2 in.	35	20	**
Tensile impact resistance, ft.-lb.	30	35	55
Endurance limit***	25	25	25

*ASTM-4 contains about 6 per cent aluminum, 3 per cent zinc, and 0.2 per cent manganese. ASTM-17 contains about 9 per cent aluminum, 2 per cent zinc, and 0.2 per cent manganese.
**Elongation values for heat-treated and aged ASTM-17 are low, and the reduction, if any, produced by the increase in grain size is inconclusive.
***Data for ASTM-4 alloy, heat treated, are somewhat scattered. The data on ASTM-17 alloy, heat treated and aged, are somewhat limited.

Commercial Methods

The present commercial method of obtaining grain refinement in magnesium alloy melts consists of the well-known process of superheating. Normally, the metal is melted in a large bulk melter, and then transferred to refining pots holding from 60 to 500 lb. of metal.

These small batches of metal are treated with a refining flux at around 1325-1350° F. The melts then are superheated to 1600-1700° F., after which they are cooled to the pouring temperature and poured as soon thereafter as possible.

This method is generally reliable, but there are instances in which the grain of certain heats refines with greater difficulty than in other heats, the exact cause of these variations being unknown.

It is a characteristic of this method of obtaining grain refinement that prolonged heating at 1700° F. may produce a rather coarse grain.[7] Holding the melt at fairly low temperatures for a short period of time also will produce a coarse grain.

Some variation in grain size from melt to melt is a characteristic of all casting alloys, magnesium base or otherwise, and most of the variables which cause these differences are unknown. However, some of these factors which control the grain size of castings poured from properly superheated magnesium alloy melts are known.

Among these are the effects of certain minor elements and the amount of scrap in the form of gates and risers in the charge. Beryllium, calcium, and cerium increase the grain size markedly.

It is sometimes claimed that a fine-grained ingot will produce finer grained castings than a coarse-grained ingot. Consequently, it would be expected that the larger proportion of scrap from castings poured from superheated metal in the charge, the finer the grain of the castings poured from the melt.

Superheating Magnesium Alloys

In general, however, most of the superheating effect is lost upon remelting and very little carry-over of grain refinement from the preceding melting operation can be detected.

It should be noted that the results of the work on W.P.B. Project NRC-550[3] on carbothermic magnesium showed that it differs from electrolytic metal in respect to the factors determining its grain size in castings. This project was carried on concurrently with W.P.B. Project NRC-546, a portion of the results of which are reported in this paper.

On the basis of the results obtained in this work, the differences noted between carbothermic and electrolytic magnesium are probably caused by the larger amounts of carbon in the carbothermic metal.

It must be concluded that the present commercial method of obtaining grain refinement in magnesium alloys by superheating is very widely used and is generally successful. However, the method has certain disadvantages:

1. The process is carried out on relatively small batches of metal. This is partly necessitated by the fairly rapid cooling required from the superheating temperature, and in part by the present commercial methods of cleaning the melt. In any event, the handling of small batches of metal requires a considerable number of small furnaces for the refining and superheating operation.

2. The relatively high temperature of the superheating operation requires considerable time and fuel, and the exposure of the steel pot to the high temperatures causes deterioration of the pot and shortens its life, thereby increasing the cost of the melting operation.

3. The exposure of the melt to the steel pot at high temperatures also accentuates iron absorption, which decreases the resistance of the alloy to corrosion.

4. Because of the time, fuel, and labor required, as well as the considerable amount of equipment and short pot life, the cost of the process is substantial.

5. The working conditions in that portion of the melting room devoted to the refining and superheating operation are not generally good, particularly during warm weather.

6. The temperature-time cycle must be carefully controlled if uniform results are to be obtained. Any delay, necessitating holding the metal near the pouring temperature after the superheating operation, tends to coarsen the grain and nullify the superheating effects.

New Method of Grain Refinement

Although the superheating operation for grain refinement has been used for many years in foundry operation, it is quite evident that some improvement in the process would be desirable.

In the early part of the work on W.P.B. Project NRC-546,[4] it was

reported that certain carbonaceous gases produced grain refinement if they were bubbled through the melt for a few minutes at a melt temperature near 1400° F. The initial results definitely indicated that the grain refinement obtained by this method was at least equivalent to that obtained by the normally used superheating operation.

Since this method could be applied to large melts at substantially lower temperatures than those used in superheating, the process did appear to have considerable practical possibilities. Consequently, experimental and development work was started to obtain the necessary information to apply the procedure on a sound and practical basis.

A new method of degassing and cleaning the melt to replace the normally used refining flux also has been developed, as described in a separate paper.[5]

This cleaning and degassing operation was applicable to large melts, also. It was logical, therefore, that a simple grain-refining operation applicable to large melts previously treated with a refining flux or with chlorine was also desirable.

Experimental Work

For this reason, most of the experimental work on grain refining was done on melts which had previously been cleaned and degassed with chlorine. In general, the grain-refining operation might precede, be simultaneous with, or follow the cleaning and degassing operation.

The experimental methods were quite similar to those described in the paper on the reduction of microporosity.[5] The usual synthetic green sand, consisting of silica sand with 4 per cent of bentonite, 1 per cent of boric acid, 3 per cent of sulphur, and 1 per cent of glycol, tempered with about 2 per cent of water, was used for green sand molds.

The melts were prepared either by the standard commercial method of using a refining flux such as No. 310, or more usually they were cleaned and degassed with chlorine as described in a separate paper.[5] The mechanical properties of test bars were obtained by using the four-bar castings shown by Fig. 1.

The melt quality, in respect to gas content, was obtained as described in reference 5 by using the wedge casting shown by Figs. 2, 3, and 4.

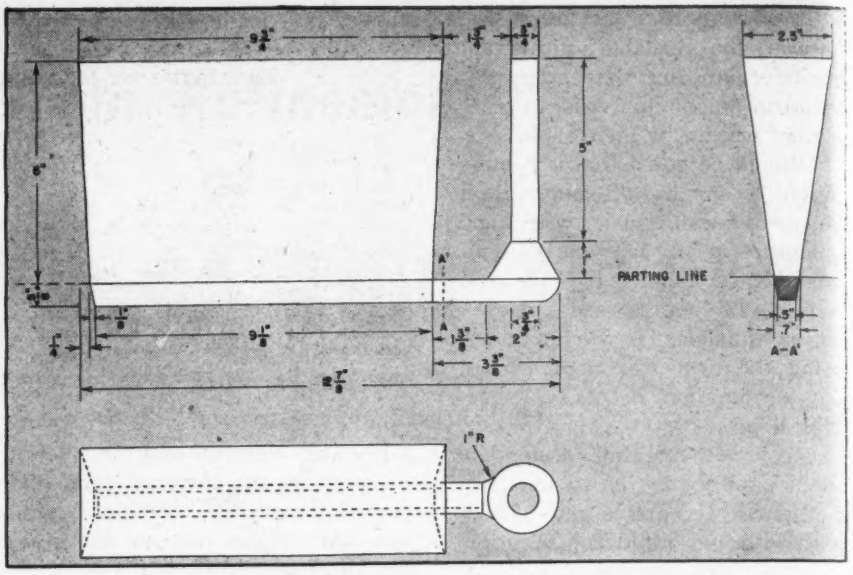


Fig. 2—Views of the wedge casting used in the investigation.

The use of these two castings, the four-bar and the wedge, also makes it possible to obtain data on the grain size obtained in a relatively light and in a relatively heavy section.

All grain size measurements were made on test bars and at a point about one in. above the bottom of the wedge by comparison with the Dow grain-size chart. All grain size measurements are expressed in thousandths of an inch, because this method has greater physical significance and is more readily visualized than grain size numbers or the number of grains per unit of area.

Cooling Rate

The grain size depends to some extent upon the cooling rate; therefore, test bars in general have a grain size of 0.001 to 0.002 in. finer than samples cut from the bottom of the wedge castings where solidification is slower.

It will be shown later that the pouring temperature has relatively no effect upon the grain size of the sand castings, except at very low pouring temperatures. Consequently, this factor, though more or less of a variable in the foundry operation, is not very important in its effect upon the resulting grain size of the sand castings.

Experience has indicated that a light, fine-grained sand casting, such as the four-bar casting, will have a grain size of approximately

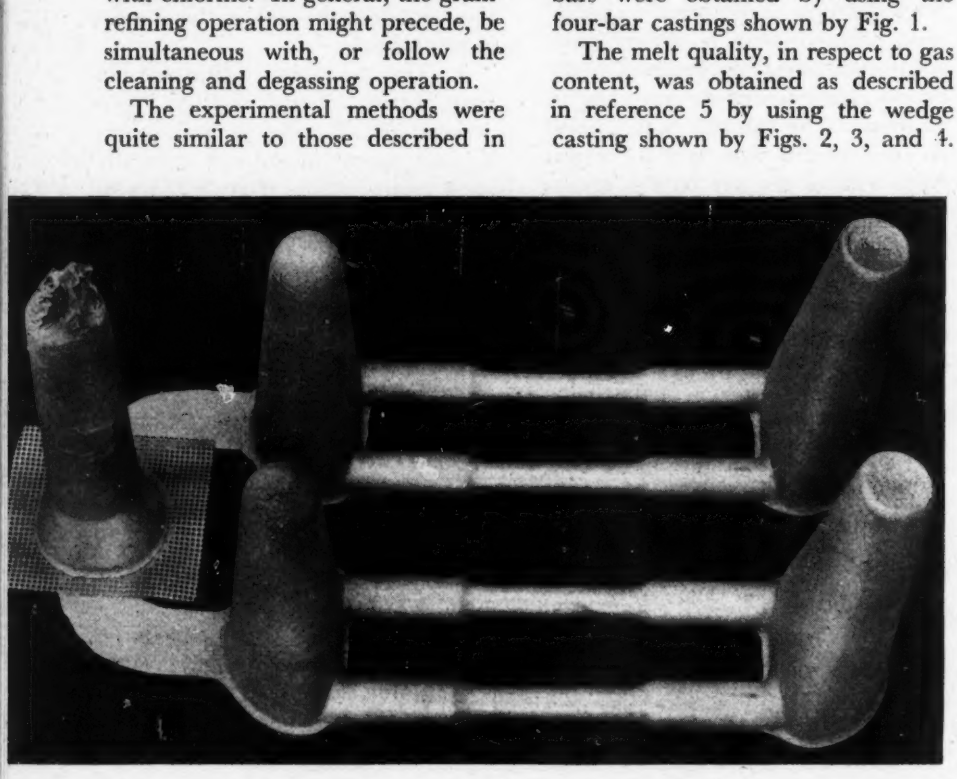
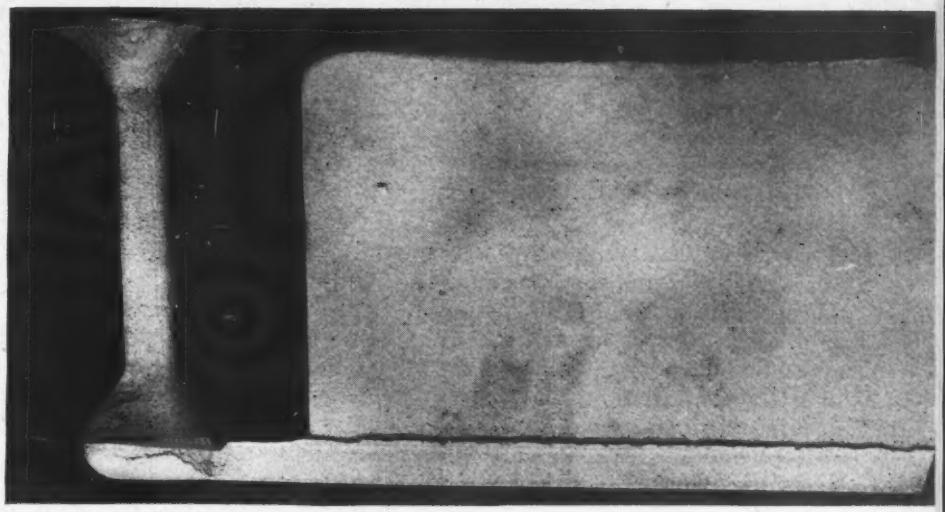


Fig. 1—Four-bar pattern test-bar casting.

Fig. 3—Photograph of the wedge casting.



0.004 in., whereas the wedge casting poured from the same melt generally will have a grain size of 0.005 to 0.006 in. because of the heavier section and slower rate of solidification.

Very fine-grained castings will have a smaller grain size than this, whereas coarser-grained castings may be considerably coarser than the figures given. Qualitatively, the grain size may be classified into five groups as being very fine, fine, moderately fine, slightly coarse, and coarse. Table 2 shows the grain sizes of the four-bar and wedge castings corresponding to these five groups.

In general, when grain sizes of 0.002 or 0.003 in. are formed by the attainments of good grain refinement plus rapid cooling, such as obtained next to a chill or in a thin fin, these fine grains may grow during heat treatment to form excessively coarse grains or "germinated grains." Consequently, these very coarse grains produce a very defective casting.

Table 2

GRAIN SIZE GROUPS

Grain Size, Qualitative	*Grain Size, in.* — *Wedge*	*Test bar*
Very fine	0.004 or less	0.003 or less
Fine	0.005	0.004
Moderately fine	0.006-0.007	0.005-0.006
Slightly coarse	0.008	0.007
Coarse	0.009 and above	0.008 and above

This defect is particularly apt to occur in alloys having a high aluminum content. Accordingly, excessively fine grains should be avoided and thin fins should be removed from the casting before the solution heat-treatment operation.[8]

Effect of Grain Size upon Microporosity Occurrence—It was noted previously that grain size control was necessary, and one of the reasons cited was that microporosity tends to be more pronounced with coarse grain.

Several heats were made in which the melt was carefully cleaned with No. 310 flux that had been thoroughly melted and dried before it was stirred into the melt. Some of these heats were superheated to produce grain refinement, while others were not. The results of this work are summarized in Table 3.

These data on the height of sound metal definitely indicate that the coarse grain accentuates the occurrence of microporosity in the wedge casting. The reason for this is not altogether clear, but it is probably logical that the difficulties of feeding the space around each individual grain in the partially solidified melt increases with an increase in grain size.

Grain Refinement by Use of Various Carbon-Containing Gases — It was found in early experiments that gases, such as carbon dioxide, acetylene, and natural gas, all produced grain refinement equivalent to that obtained by the normal superheating operation.

To avoid gassing the melt, it is, of course, necessary to use dry gases for the attainment of grain refinement. The dry natural gas was very effective and readily available. Therefore, most of the work on this type of grain refinement was performed with this gas.

The hydrogen in the natural gas apparently did not break down into atomic hydrogen, but rather into molecular hydrogen, a form which is not readily absorbed by the melt.[5]

Typical results obtained on ten different heats in which the grain was refined by bubbling dry natural gas into the melt are listed in Table 4.

These data clearly show that good grain refinement has been obtained by bubbling natural gas through the melt for 5 min. at a melt temperature of about 1400° F.

Attempts were also made to obtain simultaneous degassing and grain refinement by using chlorine and dry natural gas at the same time. These results were generally unsatisfactory; apparently the small amount of carbon which is formed in the melt is rapidly swept out by the chlorine before it has an opportunity to dissolve preparatory to its function as a grain-refining constituent.

It was of considerable interest to know whether or not the dry natural gas effectively refined commercially pure magnesium and the effect, if any, of the three common alloying constituents present in commercial alloys.

These three common alloying constituents are aluminum, zinc, and manganese. Consequently, one melt each of commercially pure magne-

Table 3

EFFECT OF GRAIN SIZE ON OCCURRENCE OF MICROPOROSITY

Number of Heats	*Metal Treatment*	*Height of Sound Metal in Wedge, in.* — *Min.*	*Max.*	*Avg.*	*Average Grain Size in Wedge, in.* — *Min.*	*Max.*	*Avg.*
7	Cleaned with No. 310 flux, using good practice, not superheated.	2⅛	3	2¼	0.010	0.040	0.020
6	Cleaned with No. 310 flux, using good practice, melt superheated.	3½	3¾	3⅝	0.004	0.007	0.005

sium, magnesium with 1.5 per cent of manganese, magnesium with 3 per cent of zinc, and magnesium with 6 per cent of aluminum was melted and the melt treated with natural gas at a temperature near 1400° F. (Table 5).

The results listed in Table 5 clearly show that aluminum is necessary in the melt before grain refinement can be obtained by the use of a carbon-containing material as a grain-refining agent. This limitation is also apparently true for the superheating operation. The theoretical significance of these data will be discussed later.

Natural Gas Treatment

The optimum melt temperature for the natural gas treatment is, of course, of considerable practical interest. Several heats were prepared and the melt treated as indicated by the date in Table 6.

The melts were treated with natural gas, using progressively increasing melt temperatures at the time of the grain-refining treatment. The results on the mechanical properties and grain size of the wedge and test bar are shown also by Table 6.

These results definitely indicate that a melt temperature at the time of the natural gas treatment should not be less than 1350° F. The theoretical significance of this observation will be discussed further at a later point in the paper.

The effect of time of natural gas treatment at a melt temperature of 1400° F. was investigated. The melt was first cleaned and degassed with chlorine, after which the grain size of the wedge and test bar were both about 0.010 to 0.015 in.

After treating the melt for 3 min. with dry natural gas, the grain size of the test bar was 0.006 in., and after a treatment of 6 min. the grain size was 0.004 in. No further improvement occurred, although the melt was treated with dry natural gas for 2 hr., during which time several test castings were poured.

The reduction in grain size effected during the first 6 min. of the dry natural gas treatment was also reflected in slightly higher tensile properties.

The effect of remelting and the effect of holding at 1350° F. was investigated, using melts of ASTM-4, ASTM-17, A-8, and AZ-91 alloy compositions which had been treated with the dry natural gas.

It was found that remelting and re-treating with dry natural gas did not produce a finer grain by successive treatments than that obtained by the first treatment.

It was also found that the grain size of ASTM-4 alloy was coarsened somewhat by holding the melt at 1300° F. However, ASTM-17, A-8, and AZ-91 compositions were not markedly coarsened by this holding treatment. It is quite likely that a lower holding temperature would have coarsened all of the alloys. In this instance the effect of holding the ASTM-4 composition after the natural gas treatment is quite similar to the effects produced by holding at the same temperature after superheating.

Table 4

GRAIN REFINEMENT BY USE OF CARBON-CONTAINING GAS

Number of Heats		Grain Size, in. — Wedge Min.	Wedge Max.	Wedge Avg.	Test Bar Min.	Test Bar Max.	Test Bar Avg.
10	Treated with natural gas after a chlorine flux, melt treated at about 1400° F.	0.004	0.020	0.008*	0.003	0.007	0.005

*One of the wedges poured in the 10 heats had a grain size of 0.020, while the test bar poured from the same melt had a grain size of 0.004. Eliminating this erratic grain size, the wedges have a range of grain size of 0.009 to 0.004 and an average of 0.0065.

Carbonaceous Gas Treatment

It may be concluded that a treatment with a carbon-containing gas, such as dry natural gas, refines the grain as effectively as the standard superheating treatment. Furthermore, about a 6-min. treatment is ample for a heat of approximately 120 lb.

Like grain refinement by superheating, the grain refinement obtained with dry natural gas is lost by remelting and by holding the melt at a low temperature. However, additional experience does indicate that metal which has been treated with a carbon-containing material does sometimes show an unusually fine grain when the metal is remelted.

Such a carry-over of grain refinement is not reliable. Later experience also indicates that melts which have been treated with a carbon-containing material do not coarsen quite so rapidly as superheated metal, and then only at very low temperatures near 1250° F.

As compared with grain refinement by superheating, the new method of treating with a carbonaceous gas has the following advantages:

1. It probably can be applied to large melts.

2. When used in conjunction with cleaning and degassing with chlorine[5] the refining furnace can be eliminated, with consequent saving

Fig. 4—Radiograph of the wedge casting showing the distribution of microporosity represented by the dark, cloudy areas on the photograph.

Table 3

RELATIONSHIP OF ALLOY COMPOSITION AND GRAIN REFINEMENT OBTAINED BY NATURAL GAS

Specimen No.	Alloy	Condition and Treatment	Castings Poured	Pouring Temp., °F.	Height of Sound Metal in Wedge, in.	Grain Size, in.	Heat Treatment	Mechanical Properties*: Tensile Strength, psi. Min.	Tensile Strength, psi. Avg.	Yield Strength, psi. Min.	Yield Strength, psi. Avg.	Elongation in 2 In., per cent Min.	Elongation in 2 In., per cent Avg.	Reduction of Area, per cent Avg.
239A	Comm. pure Mg	Cl_2 flux, 15 min. at 1250-1310° F.	Wedge Test Bar	1400	Columnar		A.C.	10,700	10,750	6,700	7,550	2.5	2.5	1.4
B		Natural gas, 5 min. at 1400° F.	Wedge Test Bar	1400	Columnar		A.C.	10,300	10,800	2,000	2,450	5.7	5.8	4.8
220A	Dow M (1.5 per ct. Mn)	Cl_2 flux, 15 min. at 1350-1400° F.	Wedge	1400	5	0.060								
B		Natural gas, 5 min. at 1350° F.	Test Bar											
B			Wedge	1400	4¾	0.100								
241A	Mg + 3 per cent Zn	Cl_2 flux, 15 min. at 1260-1310° F.	Wedge	1400	4	0.035								
A			Test Bar			0.025	H.T.	23,600	23,750	6,200	6,250	9.1	9.1	10.5
							H.T.A.	26,600	26,650	9,100	9,150	9.0	9.0	8.5
B		Natural gas, 5 min. at 1400° F.	Wedge	1400	4	0.035								
B			Test Bar			0.020	H.T.	24,600	24,950	6,200	6,250	9.6	11.0	12.3
							H.T.A.	25,700	26,350	10,000	10,100	7.8	8.1	10.7
240A	Mg + 6 per cent Al	Cl_2 flux, 15 min. at 1260-1310° F.	Wedge	1395	3	0.012								
A			Test Bar			0.007	H.T.	34,400	34,500	10,700	10,750	13.6	14.2	15.6
							H.T.A.	33,800	34,150	11,500	11,750	12.1	12.1	13.8
B		Natural gas, 5 min. at 1400° F.	Wedge	1400	4	0.007								
B			Test Bar			0.004	H.T.	36,100	36,350	11,200	11,750	15.7	15.9	18.5
							H.T.A.	32,500	33,900	12,800	12,850	9.6	11.0	11.5

*Mechanical properties based on the results from two test bars.

in time, equipment, and pot life. While these advantages over the regular superheating method are considerable, further work was done in order to obtain an easier and simpler method of attaining grain refinement.

Grain Refinement by Use of Solid Carbonaceous Materials—Since carbon appeared to be the material which produced the grain refinement, some investigation was made of solid carbon-containing additions to the melts.

Solid Grain Refiners

The various materials tried consisted of granulated graphite, granulated aluminum carbide, granulated silicon carbide, and granulated high-manganese high-carbon ferromanganese. It has been noted that before grain refinement could be obtained by the use of a carbonaceous gas, aluminum was necessary in the melt.

Since the necessary ingredients were carbon and aluminum, it seemed logical that the carbide Al_4C_3 might be an effective grain refiner. Several attempts were made to refine the grain with these various solid grain refiners.

All of these materials produced grain refinement, although there were instances in which the results obtained were rather erratic. These failures were attributed to the difficulty of placing these solid materials into the melt without allowing them to become entrapped in flux and dross, which would prevent their partial absorption by the melt.

Most of these experiments were performed by first cleaning the melt with chlorine, and then adding the solid carbonaceous material. There is, of course, the possibility of using such materials during the melting down period, after which the melt could be cleaned and degassed with chlorine.

It was concluded, however, that while such materials do produce grain refinement, the results are not sufficiently reliable to be practical.

One rather interesting observation made during the course of this investigation was the remarkable grain refinement obtained by melting in a silicon-carbide crucible.

Such crucibles contain a considerable amount of silicon carbide, SiC. Approximately 20 melts were made in silicon-carbide crucibles, and in each instance the grain size was very fine.

This grain refinement was attributed to the absorption of some carbide by the contact of the melt with the pot surface. Some silicon pickup was also observed, this amounting to about 0.005 per cent.

Such pots have the advantage of thus providing automatic grain refinement, and they also eliminate iron absorption during the melting operation. This avoidance of iron absorption should considerably improve the resistance of the alloys to corrosion.

The silicon pickup is somewhat objectionable and, with the repeated remelting that is necessary in the ordinary sand foundry, the amount of the silicon pickup would become more substantial.

A further disadvantage of the silicon-carbide crucible for large melting units is the possibility that the refractory will be penetrated by the flux which is required during the melting down operation. These fluxes are very hygroscopic, causing considerable deterioration of the refractory when the crucible is not in use.

It is concluded, however, that the silicon-carbide crucibles, possibly with a carbon lining[6] for large bulk melters, might have some practical possibilities if they were substituted for the present steel pots.

Organic Chlorides Used

Grain Refinement by Use of Volatile Organic Chlorides—Since the active grain-refining agent is carbon, it appeared logical that this element might most advantageously be added to the melt by the use of an organic chloride.

Such chlorides combine with the magnesium melt to form magnesium chloride and free carbon. This free carbon is in the finely divided state ideal for absorption by the melt.

The chlorides investigated were carbon hexachloride (C_2Cl_6) and carbon tetrachloride (CCl_4). The first chloride is a solid at ordinary temperature and pressure, but it volatilizes quite readily. Conse-

quently, it was added by means of an inverted cup which was inserted into the melt.

The heat caused the chloride to vaporize and the vapor bubbled through the melt, which was maintained at a temperature near 1400° F. These materials produced excellent and reliable grain refinement in all instances.

In addition to grain refinement, they also produced at least some degassing and cleaning simultaneously. However, the contact of the melt with the solid chloride is too short for complete degassing and cleaning.

The liquid carbon tetrachloride, however, was vaporized and the melt was subjected to this vapor for 10 to 15 min. in a manner similar to the ordinary chlorine flux. This treatment not only produced grain refinement, but also cleaning and degassing equivalent to that obtained with chlorine.[5]

Chlorine-Carbon Tetrachloride

While the carbon tetrachloride effectively degassed, cleaned, and produced grain refinement simultaneously, considerable difficulty was encountered when introducing it into the melt. A substantial volume of carbon was formed by the reaction with the magnesium melt.

This carbon tended to clog the fluxing tube, thereby causing some mechanical difficulty. This indicated that too much carbon tetrachloride was being used; therefore, the possibility of using a mixture of chlorine and carbon tetrachloride was investigated.

Cleaning, Degassing, and Grain Refining in One Operation—Considerable investigation has been made using a mixture of chlorine and carbon tetrachloride for simultaneously cleaning, degassing, and grain refining. When this mixture is used, the procedure is substantially the same as when fluxing with chlorine alone.

The only difference is that the chlorine is bubbled through a bath of carbon tetrachloride. The latter is volatile and a portion of it is vaporized and carried over with the chlorine into the magnesium melt.

Vapor Temperature

The higher the temperature of the carbon tetrachloride bath, the greater the amount of the vapor carried over. Since both the chlorine and the carbon tetrachloride change from a liquid phase to a vapor phase, both are cooled during use. Consequently, it is necessary to keep the bath of the carbon tetrachloride at least up to room temperature.

The small carbon tetrachloride baths used experimentally would drop during use to a temperature of about 55° F. unless some heat is applied by means of a water bath. At this temperature the vapor pressure is low and not much of the chloride is carried over with the chlorine.

A considerable amount of data has been obtained on this method of metal treatment, and only a portion of this is presented in this paper. Table 7 shows some typical results obtained with the mixture produced by bubbling chlorine through a carbon tetrachloride bath maintained at various temperature levels.

Table 7 shows the effect of the fluxing treatment upon the gas content of the melt as revealed by the height of sound metal in the wedge, the grain size obtained in the wedge and test bar before and after the metal treatment and after holding for a period of 15 min. after the metal treatment. The effects on the mechanical properties are also shown.

Table 8 shows the grain refinement obtained by the use of the mixture, the effect of holding at various temperatures, and the effect of reheating after the melt has been held at a low temperature. These data are the average results obtained on one heat of A-8, AZ-91, ASTM-4, and ASTM-17 alloys.

Grain Sizes

Minimum, maximum, and average grain sizes in the wedge and test bar are shown. The maximum grain sizes listed are the largest grains reported on any portion of a test bar rather than the coarsest average grain size of the test bar. These melts were prepared from 75 per cent scrap and 25 per cent new ingots.

It will be noted that the grain size after melting and before the treatment with the chlorine and car-

Table 6

EFFECT OF MELT TEMPERATURE ON THE GRAIN REFINEMENT OBTAINED BY NATURAL GAS*

Specimen No.	Alloy	Condition and Treatment	Castings Poured	Pouring Temp., °F.	Height of Sound Metal in Wedge, in.	Grain Size, in.	Heat Treatment	Mechanical Properties**: Tensile Strength, psi. Min.	Tensile Strength, psi. Avg.	Yield Strength, psi. Min.	Yield Strength, psi. Avg.	Elongation in 2 In., per cent Min.	Elongation in 2 In., per cent Avg.	Reduction of Area, per cent Avg.
208A†	ASTM	Cleaned with No. 310	Wedge	1350	1	0.015								
A	4	flux first, then natural	Test Bar	1340		0.015	H.T.	36,100	36,100	11,600	11,700	9.5	10.0	8.2
B		gas 5 min. at 1220° F.	Test Bar				H.T.A.	34,000	34,450	16,400	16,500	3.9	4.4	4.6
209A†	ASTM	Same as 208A, except	Wedge	1370	½	0.007								
A	4	natural gas added to	Test Bar				A.C.	30,900	31,150	13,600	13,750	6.7	7.0	8.3
B		melt at 1300° F.	Test Bar			0.006	H.T.	39,200	39,850	12,600	12,600	11.0	12.8	14.1
							H.T.A.	39,300	39,800	16,500	17,050	5.8	6.0	6.7
168A	ASTM	Same as 208A, except	Wedge	1390	1¾	0.004								
A	4	natural gas added to	Test Bar			0.003	A.C.	31,800	32,450	14,500	14,950	7.0	7.8	7.1
B		melt at 1360° F.	Wedge		1¼	0.004								
B			Test Bar				H.T.	43,000	43,300	14,400	14,450	17.3	17.3	20.0
							H.T.A.	41,800	42,950	19,600	19,900	5.9	6.8	7.0
210A†	ASTM	Same as 208A, except	Wedge	1390	1	0.004								
A	4	natural gas added to	Test Bar			0.003	A.C.	31,100	31,700	14,800	14,950	6.0	6.3	6.5
B		melt at 1400° F.	Test Bar				H.T.	41,800	42,400	13,500	14,000	13.8	15.1	15.6
							H.T.A.	42,700	42,900	17,600	18,550	7.2	7.4	7.5
211A†	ASTM	Same as 208A, except	Wedge	1400	⅝	0.005								
A	4	natural gas added to	Test Bar			0.003	A.C.	30,800	31,150	15,150	15,150	5.4	5.8	6.7
B		melt at 1500° F.	Test Bar				H.T.	38,800	40,800	13,400	13,800	11.0	13.0	15.9
							H.T.A.	37,700	38,850	17,300	18,450	4.3	5.0	5.7

*Cleaned with No. 310 flux only.
**Mechanical properties based on results from two test bars.
†Carbothermic metal.

Table 7

EFFECT OF SIMULTANEOUS CLEANING, DEGASSING, AND GRAIN REFINING WITH Cl_2-CCl_4 MIXTURE

Specimen No.	Alloy	Condition and Treatment	Castings Poured	Pouring Temp., °F.	Height of Sound Metal in Wedge, in.	Grain Size, in. × 10^{-3}	Heat Treatment	Mechanical Properties: Tensile Strength, psi. Min.	Tensile Strength, psi. Avg.	Yield Strength, psi. Min.	Yield Strength, psi. Avg.	Elongation in 2 In., per cent Min.	Elongation in 2 In., per cent Avg.	Reduction of Area, per cent Avg.
409A	ASTM-4	Cleaned with unfused No. 310 flux.	Wedge	1400	1½	15-30								
A			Test Bar	1390		12-30	A.C.		24,800		11,300		4.4	3.1
							H.T.	31,400	32,200	11,000	12,700	5.7	7.3	9.3
B		Cleaned with Cl-CCl_4 mixture, CCl_4 in water bath at 70° F. 0.03 lb. CCl_4 used. Treated 15 min. at 1380-1430° F.	Wedge	1400	2¼	6-8								
B			Test Bar	1390		6-7	A.C.		28,900		13,000		6.1	5.6
							H.T.	39,800	39,900	13,200	13,200	12.5	12.9	15.0
410A	ASTM-4	Cleaned with unfused No. 310 flux	Wedge	1400	2									
A			Test Bar	1390		12-25	A.C.		27,600		11,900		5.7	5.5
							H.T.	33,000	33,600	11,400	12,400	8.8	8.9	10.7
B		Fluxed same as 409B, but water bath at 80° F. 0.22 lb. CCl_4 used.	Wedge	1400	2	5-7								
B			Test Bar	1390		4-5	A.C.		28,100		14,200		4.5	4.3
							H.T.	42,500	42,500	13,400	13,400	14.6	15.3	16.1
C		Held at 1400° F. 15 min. after flux.	Test Bar	1400		7-8	A.C.		26,800		13,800		4.4	4.7
							H.T.	38,600	39,200	12,100	12,700	11.4	11.9	13.8
411A	ASTM-4	Cleaned with unfused No. 310 flux.	Wedge	1400	2⅜	25-5								
A			Test Bar	1390		12-30	A.C.		26,300		11,400		4.8	5.6
							H.T.	27,200	29,800	11,000	11,000	7.9	10.0	6.2
B		Cleaned same as 409B, except water bath at 90° F. and 0.33 lb. CCl_4 used.	Wedge	1400	3⅛	6-7								
B			Test Bar	1390		5-7	A.C.		26,100		14,300		5.0	4.8
							H.T.	37,900	38,300	13,200	13,400	11.6	12.1	13.8
C		Held at 1400° F. for 15 min. after cleaning.	Test Bar	1400		4-5	A.C.		28,600		14,100		5.4	6.7
							H.T.	39,800	40,500	12,800	13,200	11.8	12.2	14.1

bon tetrachloride is rather fine, and much finer than the as-melted grain size reported in Table 7, these latter heats having been prepared from all new ingots none of which had been inoculated with carbon or carbon-containing materials.

Table 9 shows the effect of remelting ingots which had been poured from a melt treated with chlorine and carbon tetrachloride. The as-melted grain size is again moderately fine because this material also was 75 per cent scrap and 25 per cent new metal.

It will be noted that when the ingot is remelted and heated to and poured from a temperature of 1260° F., the grain size is rather coarse. As the temperature was increased, the grain size decreased, indicating that the grain-refining constituent was taken into solution, in which condition it could be an effective grain refiner.

The decreasing grain size with increasing temperature was effected without any stirring or other agitation of the melt. It also will be noted that as the melt was allowed to cool again, grain coarsening did not occur. This is attributed to the relatively short time required to cool the melt, a time period which is not sufficient to allow grain coarsening.

It may be concluded from this work that mixtures of chlorine and carbon tetrachloride have considerable practical possibilities in the foundry. While large melts of 2000 lb. have not been treated, it is quite likely that the method would be applicable to such large quantities of metal.

It is merely necessary to melt the ingot and scrap, using a small amount of flux to prevent burning during the melting operation. When the melt reaches a temperature of around 1300° F., it may be cleaned, degassed, and the grain refined during the heating-up operation by passing a mixture of chlorine and carbon tetrachloride through the melt by means of a carbon tube.

It is believed that high quality melts can be prepared in this way. However, it should be pointed out that there is a possibility of the melt being damaged during the transfer from the large melting furnace to the mold. Work on this problem has only begun.

One of the obvious objections to the use of chlorine and carbon tetrachloride mixtures is the toxic effect of these materials. Chlorine has been widely used in aluminum foundries in which the fume problem has been successfully handled.

Since the metal treatment is confined to a few large furnaces rather than to many small ones, it is believed that suitable hoods could be constructed over the tilt furnaces to carry away the fumes, and that the resulting atmosphere in the melting room might be somewhat superior to that now existing with present commercial methods.

There are many materials which, if added to pure magnesium, will produce considerable grain refinement. Commercially pure magnesium tends to be very coarse-grained, frequently of a long columnar form. The addition of either zinc or aluminum, particularly aluminum, will cause a very substantial decrease in the resulting cast grain size.

Similar effects are common among all cast metals. These effects might be regarded as gross grain refinement. However, when additional grain refinement of these alloys is attempted, the problem becomes considerably more difficult. There is some evidence that effective grain refiners in aluminum-base materials have limited solubility in the solid state and are characterized by a very steeply rising liquidus line, beginning very near the aluminum end of the diagram.

It is quite possible and entirely logical that effective grain refiners of cast materials must have slight solubility in the liquid metal. Apparently, also, this grain-refining

Table 8

EFFECT OF HOLDING MELT AT VARIOUS TEMPERATURES AFTER Cl_2-CCl_4 TREATMENT AT 1400° F., AND EFFECT OF REHEATING TO 1450° F. AFTER HOLDING MELT AT VARIOUS LOWER TEMPERATURES

No. of Heats	After Melting — Wedge Data — Height of Sound Metal, in.	Grain Size, in.	Test Bar Grain Size, in.	After Cl_2-CCl_4 Treatment — Wedge Data — Height of Sound Metal, in.	Grain Size, in.	Test Bar Grain Size, in.	Holding Temp., °F.	Grain Size of Test Bar After Holding — 15 Min.	½-1 Hr.	2, 3 and 4 Hr.	After Holding 3 to 4 Hr., Reheating to 1450° F., and Stirring Gently — Wedge Data — Height of Sound Metal, in.	Grain Size, in.	Test Bar Grain Size, in.
4* Min.	⅜	0.004	0.004	2¼	0.005	0.004	1230	0.006	0.008	0.010	2½	0.005	0.004
Max.	2½	0.006	0.005	2¾	0.010	0.008	to	0.015	0.015	0.030	3½	0.007	0.005
Avg.	1½	0.005	0.004	2½	0.007	0.006	1260	0.010	0.011	0.016		0.006	0.004
4* Min.	⅜	0.005	0.004	2¼	0.006	0.004		0.004	0.003	0.004	3¼	0.005	0.004
Max.	1⅛	0.008	0.010	3	0.012	0.006		0.010	0.010	0.010	3½	0.006	0.007
Avg.	1½	0.007	0.007	2⅝	0.009	0.005	1300	0.006	0.005	0.007	3⅜	0.005	0.005
4* Min.	0	0.004	0.004	1¾	0.005	0.004		0.003	0.003	0.004	2⅜	0.004	0.004
Max.	⅛	0.008	0.010	2⅝	0.007	0.007		0.005	0.008	0.010	2⅝	0.006	0.006
Avg.	0	0.006	0.007	2⅝	0.006	0.005	1400	0.004	0.0045	0.0055	2½†	0.005†	0.004†
4* Min.	0	0.005	0.005	2	0.005	0.003		0.004	0.004	0.004	2	0.003	0.003
Max.	¾	0.007	0.006	2¾	0.010	0.006		0.007	0.008	0.008	2½	0.008	0.006
Avg.	¼	0.006	0.0055	2⅜	0.008	0.005	1500	0.0055	0.0055	0.005	2¼	0.0075	0.004

*One heat each of ASTM-4, ASTM-17, A-8, and AZ-91 alloys, using 25 per cent new ingot and 75 per cent scrap formerly treated with carbon-containing materials.

†Stirred gently 3 min.

constituent which is in solution must precipitate out of the melt early in the process of solidification, supplying a cloud of nuclei around which the cast grains grow.

The greater the number of nuclei supplied, the finer the grain size produced. It is not necessary that the active grain-refining constituent decompose; it merely precipitates from the liquid solution at the proper temperature to form the nuclei for the later crystals produced during the solidification of the melt.

Aluminum Carbide

This conception of the grain-refining carbon action is consistent with most, or all, of the observed experimental facts. It has been noted that carbon and aluminum are necessary before grain refinement is obtained. It is suggested, therefore, that the active grain-refining constituent is aluminum carbide.

There is, of course, a possibility that the aluminum does not occur in the active grain-refining constituent. It is conceivable that the aluminum merely changes the solubility of the active constituent so that it precipitates from the melt in sufficient quantity at the correct temperatures to produce maximum grain refinement.

It is more logical, however, to assume that the aluminum is a part of the active grain-refining constituent with the carbon in the form of aluminum carbide.

If the foregoing description of the mechanism of grain refinement with carbon in magnesium alloy melts is correct, it accounts for the following experimental facts:

1. The grain is coarsened by holding the melt at low temperatures. When the melt is held at a temperature near 1250° F., the aluminum carbide is precipitated and, when the time is sufficient, these particles either settle out or coagulate, thereby reducing the number of nuclei per unit of volume of melt and, consequently, increasing the grain size when the melt solidifies.

2. After holding at a low temperature and then reheating, grain refinement is restored. When the melt is reheated after it has been permitted to stand for a few minutes or several hours at a temperature of 1250° F., the coagulated nuclei are redissolved and the effectiveness of the grain-refining action of the carbon is nearly as great as ever.

Since it is not necessary to stir the melt after the holding period at the low temperature, but merely necessary to reheat it, it is concluded that the aluminum carbide is precipitated and coagulated but does not actually settle out completely.

If it did settle out completely, it is logical that some stirring would be essential before effective grain refinement would be restored. However, it has been noted that gentle stirring aids the restoration of the grain refinement, and it is concluded that the coagulated nuclei do tend to settle slightly.

3. As the temperature of the holding period increases, the grain coarsening produced by the holding decreases. The reason for this obviously is that the higher the holding temperature the less the precipitation of the aluminum carbide, and consequently there is less coagulation of the grain-refining constituent. Most of the grain-refining constituent remains in solution where it can effectively refine the grain when the melt solidifies.

4. When a melt is treated with

Table 9

EFFECT OF REMELTING INGOT FORMERLY TREATED WITH Cl_2-CCl_4**

Condition	Wedge Data — Height of Sound Metal, in.	Grain Size, in.	Test Bar Grain Size, in.
As melted, 75 per cent scrap	¼	0.006	0.004-0.005
Treated with Cl_2-CCl_4	2⅛	0.006-0.007	0.006-0.007
Pigged, remelted only			
Poured at 1260° F.			0.008-0.10
Poured at 1350° F.			0.004
Poured at 1450° F.*			0.003-0.004
Poured at 1350° F.			0.003
Poured at 1250° F.			0.003

*The pouring temperature is also the maximum temperature except for 1450° F., the maximum temperature in this case being 1480° F.

**Melt was not stirred when the ingot was remelted

the chlorine - carbon tetrachloride mixture and the grain refined thereby, the melt pigged off and the ingot remelted, the grains are coarse at the low pouring temperature, but as the temperature increases the original grain refinement is again obtained. When the melt was pigged off, the aluminum carbide, of course, precipitated.

Effect of Remelting

When the metal containing this finely divided suspension of aluminum carbide is again melted, some coagulation occurs at low temperatures, thus causing a coarse grain. However, when the temperature is increased, even without stirring, more of the aluminum carbide is taken into solution, and the grain size gradually decreases as normal foundry pouring temperatures of 1400-1470° F. are reached.

5. When the melt is treated with the carbon-containing gas at a low melt temperature near 1250° F., the grain-refining effect is not very marked because the solubility of the aluminum carbide is too low at this temperature. If, however, the melt treatment temperature is increased to near 1400° F., the temperature is sufficiently high to produce adequate solution of the aluminum carbide constituent and thereby obtain good grain refinement upon solidification.

6. Solid carbon-containing materials are not always effective because it is too difficult to obtain sufficient solution of the carbon portion of the material.

Carbon in Atomic Form

Organic chlorides are especially effective because the vapor from the organic chloride combines with the magnesium melt, forming carbon in an atomic form and magnesium chloride. The carbon in atomic form is in an ideal condition for solution in the melt. Consequently, this method of grain refining is invariably effective and reliable.

7. The fact that carbothermic metal tends to be finer grained than electrolytic metal can be attributed to the higher carbon content of the former.

8. It has been noted that quite frequently very coarse grains are obtained at a pouring temperature near 1250° F. However, in some instances, fine grain is obtained at low pouring temperatures.

Apparently the important factor

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is the amount of time the melt is maintained at the low temperatures before it is poured into the mold. If cooling is fairly rapid, coagulation of the precipitated aluminum carbides does not occur when the low pouring temperature is reached and fine grains result.

Cooling Rate

If the cooling rate of the melt near the pouring temperature is very slow, coagulation of the aluminum carbide does occur, and a coarse grain is produced when the melt solidifies. All melts, of course, pass through this range when they are poured into a mold and solidify.

The time lapse, however, is generally very short and no coarsening occurs. Consequently, if low pouring temperatures are used, it is necessary to cool to these temperatures fairly rapidly. Otherwise, grain coarsening will occur. This is probably the reason that large melts are difficult to superheat in the foundry because the cooling rate of the large melt is too slow to maintain the grain-refining effect.

Low pouring temperatures are not ordinarily encountered in foundry operation. However, in ingot and billet casting shops, low pouring temperatures and large melts are used, and it is under these conditions that considerable variation and trouble can be encountered because of the adverse effect of slow cooling upon the effectiveness of any grain-refining operation which is attempted. Of course, some wrought alloy compositions are not amenable to any known grain-refining procedure.

Superheating Function

The behavior of the superheated metal has not been investigated, in a systematic manner, in this work. Consequently, it is somewhat hazardous to suggest that the function of superheating is essentially the solution of the grain-refining constituent, probably aluminum carbide.

Superheated melts have characteristics very similar to those which have been inoculated with carbon at lower melt temperatures than those used for superheating. Apparently, however, superheated melts coarsen at somewhat higher temperatures.

The grain size produced by superheated melts is more adversely affected by holding at intermediate temperatures than are melts which have been inoculated with carbon. If the grain-refining effect obtained by superheating is due to solution of aluminum carbide, there is no apparent reason why superheated melts should not perform exactly the same as melts which have been inoculated with carbon.

Since no definite measures are taken to subject the melt to a carbon source at the superheating temperatures, it is quite logical that some variable results might be obtained with the superheating operation, some melts being much more amenable to grain refinement than others.

Refining Flux

Commercial fluxes used for melting magnesium usually contain carbon, and some grain refinement is obtained by the usual cleaning operation with the refining flux. However, the melt temperature for this treatment is on the low side for effective carbon absorption.

Even melts of magnesium produced by the electrolytic process contain some carbon. In any event, it would be expected that there would be sufficient carbon present in the flux, pot, or metal to produce grain refinement by carbon absorption when subjecting the metal to a high temperature.

In this connection, it should be noted that long exposures to high temperatures during the superheating operation sometimes actually produced grain coarsening. This has not been checked with carbon inoculation, but it is quite possible that the same effect could be observed.

This phenomenon could be explained as follows: The long time at a very high temperature gives ample opportunity for a high degree of solution of carbon in the melt.

When the melt is cooled, the aluminum carbide precipitates out of solution at too high a temperature because of the high concentration of this constituent. This condition would favor coagulation of the precipitated grain refiner, producing coarse grains when the melt solidifies.

A method of producing high quality magnesium melts has been de-

scribed in a separate paper.[5] As a part of this general program, this paper describes a method of obtaining grain refinement in the melt cleaned and degassed by the new method.

Summary

In general, magnesium alloy melts containing aluminum can be treated to produce grain refinement by using a carbonaceous material, which may be a carbon-containing gas, such as dry natural gas, a solid such as graphite or aluminum carbide, or a vapor from an organic chloride.

The carbonaceous gas is as effective as superheating, but there is the danger of regassing the melt if this gas is not dry, and the method is slightly awkward and time consuming. The carbonaceous solids are generally effective, although the results are sometimes erratic because of the difficulties of obtaining proper solution of the carbon from such materials.

The organic chlorides are very reliable, give good grain refinement, and also provide some cleaning and degassing effect normally obtained with chlorine.

It has been found that a mixture of chlorine and carbon tetrachloride obtained by bubbling the chlorine through a bath of the liquid tetrachloride effectively and reliably degasses, cleans, and produces grain refinement in one operation.

This procedure has been very successful on melts weighing up to 120 lb. It is believed that the method is applicable to the large melts which might be obtained in normal foundry operation, such as those prepared in a 2000-lb. tilt furnace.

Recommended Temperatures

Proper methods of transferring this melt to the mold, either directly or by way of a ladle, are being investigated. Temperatures of around 1350-1450° F. are recommended for treatment with the chlorine-carbon tetrachloride mixture.

The grain size of castings poured from such melts is increased by holding the melt near a temperature of 1250° F. This adverse effect on grain size gradually decreases with increased temperatures until at 1400° F. only a very slight coarsening occurs after several hours at this temperature.

The grain-refining effect which is lost by holding at low temperatures is restored by simply reheating to 1400-1450° F. It has been found that there is a considerable carry-over of grain refinement when such metal is remelted, the grain size gradually decreasing as the maximum temperature and pouring temperature approaches 1450° F. It is quite possible, however, that for reliable grain refinement, each melt should be treated and the carry-over from the preceding treatment should not be relied upon.

A general theory of the mechanism whereby the carbon inoculation produces grain refinement has been described. It is suggested that aluminum carbide, Al_4C_3, is the active grain-refining constituent, and this compound is dissolved in the melt.

When the melt is cast, the aluminum carbide is precipitated near or slightly above the liquidus line at which solidification begins, producing a cloud of nuclei around which the individual grains form. The greater the number of nuclei per unit of volume of melt, the finer the grain which is produced.

Acknowledgment

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• COMMITTEE REPORT

Foreman Training Program Must Be Established Now

By Chairman F. E. Wartgow, Hasbrouck Haynes, Chicago

THE Foreman Training committee, American Foundrymen's Association, has in the past conducted meetings at the convention. These meetings have brought to the members, ways and means of conducting foreman training programs.

This year, due to the cancellation of the convention, we have planned a paper, written by Steven G. Garry, foundry division, Caterpillar Tractor Co., Peoria, Ill. The paper is entitled "Engineer of Human Relations," and will be published in the AMERICAN FOUNDRYMAN at some future date.

We know this will be of great interest to all.

Foreman training programs are very essential to successful foundry operations. A good wage incentive plan with productivity controls, provides a suitable frame upon which a sound foreman training program can be built.

Foreman training in the post-war period will be just as important as it has been during the war. As soon as we have overcome the Japanese we will find ourselves in a period of readjustment. All such periods are trying ones, and especially for the foreman.

Now is a good time to start your foreman training program for the post-war period, a step which will be a large factor in solving readjustment problems.

Safety Training Film Material Now Available

A NEW series of eight discussional type slidefilms, "Basic Shop Safety" totalling several hundred training pictures, is now available to local industries through The Jam Handy Organization, 2900 E. Grand Blvd., Detroit.

COLORIMETRIC DETERMINATION

of

Nickel and Chromium In a Combined Form of Analysis

• Progress in metallurgy and engineering indicates that postwar composition and physical property specifications for castings will be more exacting. The development of an economical, reliable, and flexible method for routine control analysis of straight carbon and alloyed steels, and irons, enables foundrymen to meet requirements, both as to total amounts of alloying elements and limits for various elements present as residual alloys.

By Winfield B. Sobers,

Development and Control Laboratories, Chain Belt Co.,

Milwaukee

ONE of the problems of the metal industry today, and during the postwar years, will be to conserve critical alloying elements in variable amounts, as found in high and low alloy steel and cast iron products as return scrap.

Also, to have adequate control of the chemical composition and resulting physical effects (hardenability, weldability, forgability, machinability, carburization, structural properties, etc.) of residual or tramp alloys that may be present in the molten metal, solid castings, ingots or finished metal products.

Technical control (chemical and physical), adequate inspection, and properly written specifications will play a leading part in the buying of quality castings and metal products in the postwar era. This responsibility will fall on up-to-date purchasing departments where personnel has been developed and trained to obtain, under written specifications, the most value for the employer's dollar.

For the foregoing reasons, the author feels that the combined form of analysis, originally developed in Chain Belt Co. Metallurgical Laboratory, in conjunction with colorimetric determinations, offers a more economical, accurate, rapid, reliable, reproducible and flexible method for routine control analysis of straight carbon and commercial alloy steels, and irons, than is offered by the older conventional methods.

The following method for nickel is a modification of the Murray and Ashley colorimetric determination.[5] The method of Murray and Ashley has been used with some success, although it has certain undesirable characteristics due to the change in color developed after the addition of dimethylglyoxime.

This effect is more pronounced, and the results are less reproducible, where amounts of less than 0.50 per cent nickel are involved. Since one of the problems of the metal industry will be to conserve critical elements in variable amounts as residual alloys, it is apparent that a rapid satisfactory method for nickel would be very desirable.

From experience, the author has found the following modified method as worked out in this laboratory to be readily reproducible, and to be particularly suitable for routine analysis when applied in conjunction with the combined method of analysis as previously outlined.[1, 2]

Due credit should be given to G. R. Makepeace and C. H. Craft, Menasco Mfg. Co., Burbank, Calif., for recommending the use of sodium hydroxide to stabilize the wine red color.[3] This has been improved upon by separating the iron with an emulsion of zinc oxide, thereby eliminating the interference of iron, especially on small amounts of nickel.

In other words, the nickel glyoxime color is developed on a colorless or water-white solution and any color that does develop after the addition of dimethylglyoxime is due entirely to the presence of nickel without interference of iron. An outline of how the colorimetric method for nickel and chromium is applied in conjunction with the combined method follows:

Treat a one-gram sample with 5 ml. of dilute nitric acid (1-1) and 20 ml. of perchloric acid (70-72 per cent). (If chromium is not desired, use 10 ml. of perchloric acid to dissolve the master sample.) Take to short of dryness (*do not bake*) as previously outlined,[1] with the exception that 1 ml. of perchloric acid is added from a burette, in place of nitric acid, to dissolve the soluble salts.[2] After filtering and washing into a 100 ml. volumetric flask, dilute to mark and mix.

Silicon—Finish as previously outlined.[1]

Manganese—Pipette out 20 ml., finish as previously outlined.[1]

Molybdenum—Pipette out 10 ml., finish by the colorimetric method.[1]

Phosphorus—Pipette 5 or 10 ml., finish by the colorimetric method.[2]

Revised Nickel Determination

Pipette out 10 ml. of solution from the 100 ml. volumetric flask and transfer to a 200 ml. volumetric flask, dilute to mark and mix with water at approximately 100° F. (1 ml. = 0.0005 grams). Transfer 50 ml. (0.0250 grams) of this solution to a 100 ml. Barrett separatory funnel (Figs. 1 and 2). Add 2 ml. of zinc oxide solution and shake vigorously to precipitate the iron, dilute to 100 ml. Allow precipitate to settle for 3 or 4 min. and draw off the bottom 50 ml., which will include the precipitate of iron hydroxide.

The remaining 50 ml. is transferred to a 100 ml. volumetric flask. (A 100 ml. volumetric flask may be used in place of the 100 ml. Barrett separatory funnel. After separating the iron, filter 50 ml. into a 50 ml. volumetric flask, the 50 ml. of iron free solution is transferred to a 100 ml. volumetric flask and finished as outlined.)

Standard Solutions

The following reagents (see Table) are added in the order given, mixing after each addition: 3 ml. of 10 per cent tartaric acid solution, 5 ml. of saturated bromine water, 10 ml. of concentrated, ammonium hydroxide, 3 ml. of one per cent dimethylglyoxime solution, 5 ml. of bromine water. After one or 2 min., add 10 ml. of 5 per cent sodium hydroxide solution and dilute to mark with water and mix. After 10 min., check at 475 mu wave length, using distilled water in the reference cell (Fig. 3).

The red color is stable, with no appreciable change after setting for a period of several days. This is not true for nickel contents of less than 0.10 per cent, and they should be checked within the first hour.

For nickel contents of less than 0.10 per cent, use 5 ml. of solution direct from the 100 ml. master solution and add 3 ml. of zinc oxide solution in place of 2 ml. Finish as outlined and divide results by two (2).

For each additional 1.00 per cent nickel present, add an additional 100 ml. of water to the colored solution. For example, for approximately 5.00 per cent nickel, transfer to 500 ml. volumetric flask and dilute to mark and mix, multiply results by five (5) to convert to percentage of nickel.

It may be of interest to note that this method for nickel may be applied to non-ferrous metals and alloys.

Fig. 2—Quantitative colorimetric solution as prepared for the determination of nickel, phosphorous, chromium and molybdenum. Table is especially constructed, with dull green background and milk glass top, to give visual contrasts of various colored solutions.

Fig. 1—Showing (at left) the six 100 ml. Barrett separatory funnels and support, as used for the separation of iron from nickel.

Determination of Chromium

Louis Singer and W. A. Chambers, Jr., Naval Research Laboratory, Washington, D. C., have applied the perchloric acid oxidation method for the direct colorimetric determination of chromium in steel.[4] Although the method has been in use for several years, Singer and Chambers are the first, to the author's knowledge, to apply it as a direct quantitative color method.

The basis of the method lies in the fact that ferric perchlorate, which is itself colorless, intensifies the color of the dichromate ion. The method is not subject to interference by the usual alloying elements. However, large amounts of alloying elements may produce appreciable error.

After having withdrawn aliquot proportions for manganese, phosphorus, molybdenum and nickel, the remaining master solution is used for the determination of chromium.

Analytical Procedure — If chromium content is less than 0.10 per cent, do not dilute the remaining oxidized chromium solution in the 100 ml. volumetric flask. Transfer 25 ml. of this oxidized chromium solution to a small beaker and reduce with one drop of reducing solution (0.0100 grams). Use this

reduced chromium solution in place of water in the reference cell. Compare at 455 mu wave length and apply curve *C* (Fig. 4).

If chromium content is from 0.10 to 1.00 per cent, adjust the remaining oxidized chromium solution in the 100 ml. volumetric flask to 50 ml., dilute to 100 ml. and mix. Transfer 25 ml. of this oxidized chromium solution to a small beaker and reduce with five (5) drops of reducing solution (0.0500 grams). Compare at 455 mu wave length and apply curve *A* (Fig. 5).

Above 1.00 per cent to 2.40 per cent chromium, reduce 25 ml. of the oxidized solution with 10 drops (0.1000 grams) of reducing solution, compare at 490 mu wave length and apply curve *B* (Fig. 5).

For chromium above 1.00 per cent, one may dilute approximately every 0.70 per cent chromium present with an additional 100 ml. of water, compare at 455 mu wave length and multiply by correction factor to convert to percentage of chromium.

Percentage of Error

Samples having a chromium content of between 0.10 and 0.30 per cent may use the remaining oxidized solution without diluting. Apply curve *A* (Fig. 5) and divide the results by two (2) to convert to percentage of chromium.

Due to contamination of the dichromate ion with silicic acid, an appreciable error may be expected if the silicon content is in excess of 1.00 per cent and the normal graphs are applied. However, for cast irons and steels containing higher silicon contents, supplementary graphs may be plotted against suitable standards of known silicon and chromium content.

The author would not recommend the method for irons containing approximately 2.00 per cent silicon and having less than 0.20 per cent chromium. One may expect the chromium percentage error to increase as the percentage of silicon increases and the percentage of chromium decreases.

An additional precaution is the amount of free perchloric acid present; for this reason we take the initial or master sample to short of dryness *(do not bake)* and redissolve the soluble salts with 1.0 ml. of perchloric acid added from a burette in order to have the acidity under control for the various determinations to follow.

For example, if 5 ml. of perchloric acid is used in place of one ml., low chromium values will result. Temperature of the final solution should be adjusted to within a few degrees of room temperature.

Singer and Chambers[4] add ferrous ammonium sulfate crystals (about 10 to 20 mg.) as a reducing agent. The author has found it necessary to have this reducing solution under closer control; this is especially true for amounts of chromium less than 0.10 per cent. It is also a means to establish a more relative constant factor for a given solution in the reference cell.

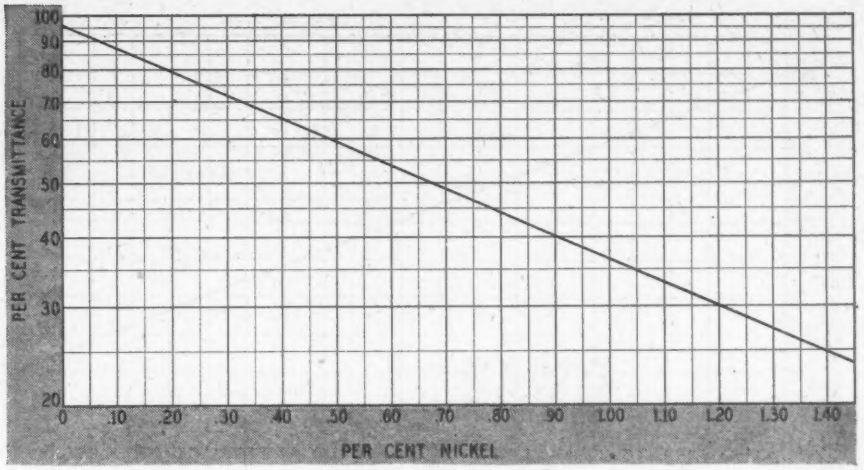

Fig. 3—Nickel in steel colorimetric determination. Sample, 0.0125 grams diluted to 100 ml. Wave length, 475 mu.

STANDARD SOLUTIONS*

Zinc Oxide	
100 grams	Zinc Oxide
1000 ml.	Water
Tartaric Acid	
100 grams	Tartaric Acid
1000 ml.	Water
Bromine Water	
454 grams	Bromine
2000 ml.	Water (approx.)
Dimethylglyoxime	
100 grams	Dimethylglyoxime
1000 ml.	Alcohol
Sodium Hydroxide	
50 grams	Sodium Hydroxide
1000 ml.	Water
Reducing Solution (Cr)	
5 grams	Ferrous Ammonium Sulphate
24 ml.	Water
1 ml.	Perchloric Acid

*Transfer solution to a suitable dropping bottle so that 20 drops will approximately equal 1.0 ml., or be equivalent to 0.2000 grams of the salt (1 drop equals 0.0100 grams). Make fresh solution each week.

Conclusions

Since colorimetric determinations require only a small amount of sample, it is evident that, by applying the combined method of analysis, a more representative sample is obtained by taking aliquot amounts from a large initial weighing of the sample, diluted to its proper volume, than can be obtained by direct weighing a few milligrams of sample.

It is also evident that an appreciable saving in chemicals results, since several determinations may be made from aliquot proportions from the master solution. Also, it is not necessary to use chemicals to dissolve individual samples for various

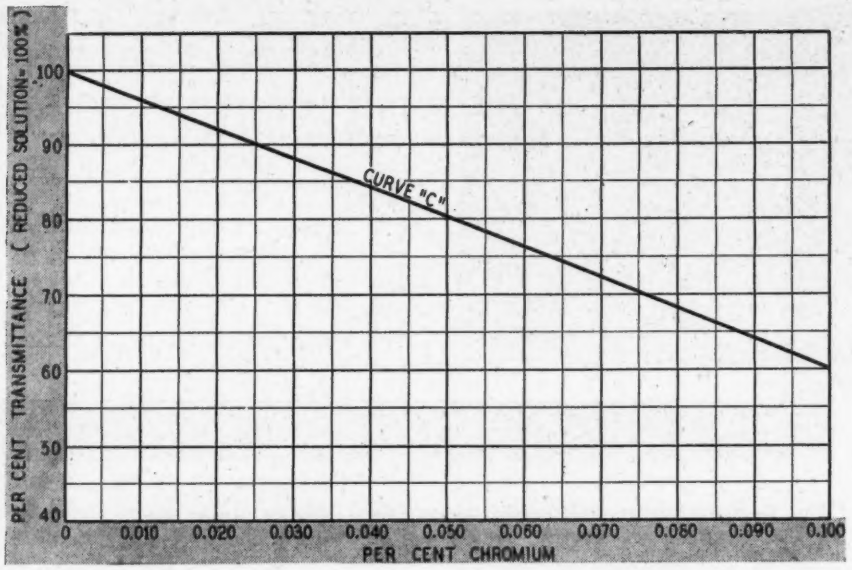

Fig. 4—Chromium in steel colorimetric determination. One-gram sample diluted to 100 ml., 25 ml. reduced with 0.0100 grams of ferrous ammonium sulphate. Wave length, 455 mu.

determinations, as required by the older conventional direct methods.

Calibration and analysis should be made under exactly the same conditions, using standards of near like composition. The values may be determined from a smooth curve as readily as from a straight line. The curve should be plotted in the wave length range in which the greatest change in transmission occurs with a change in concentration of the substance.

Should the highest degree of accuracy be required, this can be obtained by making several graphs of the various working ranges needed in any particular case. For example, the nickel curve (Fig. 1), plotted from 0.0 to 1.45 per cent nickel, could be broken down into five (5) separate curves, each curve covering a range of 0.29 per cent nickel and plotted in the wave length range in which the greatest change in transmission occurs for a given color or concentration of the element involved.

When working with solutions containing a high concentration of the element involved, close control of water temperature used for diluting, aliquots withdrawn from the master solution, and other factors should be under more elaborate control than for master solutions having a low concentration of the elements involved.

In the future, one may expect more rigid written specifications for the total amount and limits for various elements that may be present as residual alloys in a given metal product. Modern metallurgy and engineering will make this a necessity.

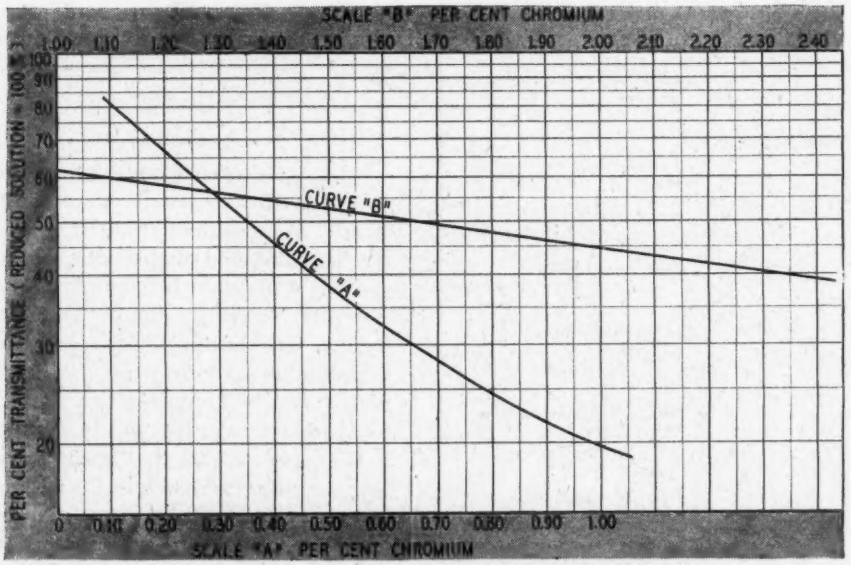

Fig. 5—Chromium in steel colorimetric determination. One-gram sample to 200 ml. Curve A, 25 ml. reduced with 0.0500 grams of ferrous ammonium sulphate. Wave length, 455 mu. Curve B, 25 ml. reduced with 0.1000 grams of ferrous ammonium sulphate. Wave length, 490 mu.

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Three Welding Courses At Lincoln Electric Co.

THREE new, specialized courses in arc welding are announced by The Lincoln Electric Company, Cleveland, which are designed to increase the student's knowledge of the shielded arc process as applied to specific metals and structures.

The courses consist of one two-week training period to instruct enrollees in the technique of arc welding the common steel alloys and non-ferrous metals. A second course of one week's duration is devoted to instruction in welding sheet metal in thicknesses of from 12 to 20 gauge. A third, two-week course is intended to train students in the welding of pipe in diameters of from 2 to 10 inches.

One of the oldest schools of its kind in continuous existence, it has trained over 25,000 people in this profession.

Fig. 1—Sand under the microscope. A magnesium sand at 40x. Top—New sand. Bottom—Reclaimed sand.

SAND RECLAMATION

By Ronald Webster and A. C. Den Breejen,
Hydro-Blast Corp.,
Chicago

• Improving castings quality by the use of reclaimed sand. Within certain limits, the sand reclamation process in itself controls sand grain size and distribution, cleanliness, moisture content and temperature. Sand storage and waste disposal problems are solved in many instances.

THE dollar interest is probably not the dominant human motive, but it is an important one and a very good measure of the practicability of any reform or of any good intention. The dollar stands as a constant critic over our acts and limits them.

If the systems for the recovery of sand now wasted from foundries could not show a dollar saving, it would be very hard to bring them into use, even if the results were superior to results previously obtained. It is our primary contention that the quality of castings which can be produced in a foundry using a reclaimed sand will be better in most instances and on the average than can be produced from new sand. However, the money saving cannot be overlooked; it is there.

The statement concerning the quality of castings will be less startling when it is apparent that a sand reclamation system is a compulsory sand control, with all that that implies. It can and will give control, within certain limits, of the grain size and distribution, cleanliness, moisture content and even the temperature of the sand. Because one starts with a known quality which can be the same every time, refinements in procedure in amounts of bond, moisture, mulling time, etc., will have meaning.

Waste Sand Economic Aspects

This preface concerns itself with the economic aspects of sand reclamation systems, and begins with the point that *sand is the most considerable item of waste in most foundries.* This waste comprises a great deal more than the cost of the new sand. Whenever new sand is bought, an equivalent amount of waste sand must be hauled away or the foundry will fill up. Disposal charges must, therefore, be added.

In addition, there are unloading and other handling charges, but the major item is storage space for the winter months in those regions where it can neither be delivered or stored outside during a part of the year. All of this must be added to the cost of the sand.

It is now practicable to wash, scrub, classify and dry foundry sands of most kinds for somewhere between 50 cents and one dollar a ton, including the following items: power, water, fuel, direct labor and maintenance with its labor. The precise process and the precise equipment necessary for any given plant and process can be determined only by a study of the individual foundry, although foundries fall into several definite groups.

In very small foundries, the capital cost of equipment to accomplish this purpose will be too great; also, labor costs increase sharply with decreased volume. For example, one man can operate a system delivering 15 tons an hour about as easily as he can operate a system delivering 5 tons an hour or, for that

matter, one ton of sand per hour.

Not only the very small foundry but certain other types of foundries are not in a position to consider sand reclamation systems. Typical of these are many foundries in England where the material used in molding is not sand but chamotte or loam, or in this country, foundries using cement, which latter presents its own particular difficulties.

Sand Quality

Certain other foundries cannot well use a reclamation system because of the quality of the sand they now employ. These foundries have found it economical in the past to use a relatively cheap sand available locally, even where it is weak and the loss is very great.

This condition obtains most conspicuously in the Pacific Coast area, where very few really good sand deposits have been found. In many of these foundries, a reclamation system will justify a change of sand and of sand practice from local sand with a low initial cost to a better sand obtained even at a much greater cost from a distance, or the use of a high grade local sand if it is available.

Granted a recovery of 85 per cent, which is quite possible with a good sand of the proper grain shape, it will be cheaper to start with a sand at $10.00 a ton than with an unsatisfactory sand at $2.00, and better castings will result. This, in a way, frees the foundryman from the purchasing agent and permits him to make a technical improvement at a saving.

Special Materials

In some exaggerated cases, reclamation systems will permit the use of special materials needed to accomplish some particularly desirable result. From the dollar point of view, if it were desirable technically, it would be possible to use zirconium silicate in large quantities instead of silica sand, provided that a recovery of 90 per cent could be obtained. This, of course, would hold only in special cases where the supposed advantages of a very high sintering point would warrant the use of the material. If is merely pointed out that economically such a step would be possible, if it were desirable.

The question of disposal of waste sand deserves further elaboration. Many foundries were built on what was apparently waste land, quite often in swamps, and the waste material was used as fill. Certain long-sighted foundry executives selected sites which later became real estate developments. The swamps do not last forever and the real estate developments become realities, and the problem arises sooner or later of hauling sand a greater distance and paying a premium for the privilege of dumping it.

In some cases, also, the sand used to be dumped into rivers, a practice which is not looked upon with any favor by local communities. A great many foundries are, therefore, faced at this moment with increased disposal costs running from $1 to $2 or $3 a ton.

It might also be pointed out here that the scrap sand usually contains a considerable amount of iron. Under war conditions, this loss of metal has been greatly reduced by the amount which could be salvaged as a by-product of the sand reclamation system, and is another item on the profit side.

Sand Storage

Storage space is an interesting by-product of a sand reclamation system. Assuming an average use in steel foundries of one ton of new sand for every ton of castings produced, and regarding the transportation season as closed for 4 months of the year, it is easy to arrive at a minimum safe storage capacity for a foundry of any size. Bins cost money and take up space, and to be useful require a roof.

A sand system with a yield of 85 per cent will eliminate the need for 85 per cent of this storage space. In several instances, the cost of bins with their handling system was not greatly less than the cost of a system to reclaim the sand.

Outside storage is a practical impossibility in a well-conducted foundry. Some foundries have been forced to store the sand outside, but few like to do so. They anticipate difficulties whenever they have to use sand from an outside pile unless they have equipment to thaw and dry it.

Most foundrymen have also had experience with wet cars and with frozen cars. It is common practice in many foundries to dry all core sand in any event, thus gaining one of the advantages of a reclamation system, namely, a controlled moisture content. Drying sand in this method is not as economical as it could be. Some cars are much wetter than others, and drying systems have to be overdesigned to meet the extreme conditions.

Drying Core Sand

It is not always easy to change the setting of burners when relatively dry sand is received, and the sand is overheated and retains its heat for a long period in the storage bins. This will have a particularly bad effect in large corerooms where cores are made on a production line. The temperature of the sand is important in the control of moisture and, under some conditions, may result ultimately in stickiness in core boxes.

In the preparation of this paper, which does not go into the economies of sand reclamation, data were obtained from the results in seven or eight foundries which have used this system over many years and processed many thousands of tons of sand; and from a pilot plant having a capacity of between one and three tons per hour, dependent upon the particular problems to be solved. Sand from more than 100 foundries has been run and examined in this pilot plant. Most of the runs were based on 5-ton lots of waste sand.

The sand has been collected from many sources—floor sweepings, core butts, shakeout material. In many cases, the reclaimed sand was returned to the foundry and used in cores or in facing material with satisfactory results. Processing of lots of less than 5 tons is not considered significant. Laboratory tests in themselves mean nothing whatever. The answer is good castings.

Sand Reclamation

Definition—By sand reclamation is meant the processing of spent foundry sand, normally wasted, in such a manner that it may be used in place of new sand without substantially changing current practice.

It is necessary to make this definition clear because the term has been applied to a variety of processes in which this object was not attained and, perhaps, not sought. In this paper, the word "recovery" will mean the percentage of treated sand, suitable for use instead of new sand, which is yielded from any specific sand reclamation system.

The subject matter is of almost

no interest to foundries using naturally bonded sands, but the practice in such foundries of adding new washed sand or relatively clean spent core sand to keep up the permeability of the naturally bonded molding sand serves to bring out another point, and may better define the objects of this paper.

In several foundries visited, some official has flatly asserted that they already recover their core sand. Upon further inquiry it developed that they were permitting a portion of their used core sand, or all of it, to mix with the molding sand to maintain its permeability and, at the same time, adding bond to keep its strength. In such cases, of course, they were buying new sand for use in cores and in facings, and were wasting tonnage roughly equivalent to the new sand which was purchased.

Core Sand Production

In one foundry visited 5 or 6 years ago, there was no apparent waste, but the foundry superintendent pointed out that the floor at one end of the foundry was 4 or 5 ft. higher than it had been 2 or 3 years before. These foundries are, of course, making molding sand out of core sand. However, they are not reclaiming core sand in the meaning of this paper.

Whatever the practice, core sand is almost invariably a new sand relatively free from bond, sometimes mixed with used sand in small proportions and frequently with the additions of material like silica flour, oil, small percentages of fire clay and some material such as cereal flour. The point is that for cores and some facings new sand is, by more or less common consent, required. It is the production of this sand, or its equivalent, from waste materials to which the various processes of sand reclamation are pointed.

Nature of Sand—To accomplish the purpose of producing a good core sand from spent core sand or from molding sand, it is necessary to examine the characteristics of individual sands and even individual sand grains at some length before attempting production.

A.F.A. standards classify sands into angular, subangular and round grains. Inasmuch as these sands have been laid down by nature and are the result of erosion and of natural water classification, the shape of the sand grains in themselves gives a clue to certain of their physical characteristics.

This paper was secured as part of the 1945 "Year-'Round Foundry Congress" and is sponsored by the Steel Division of A.F.A.

Sand Grain Shapes

The angular grains must have sharp cleavage planes and must be weak or they would not have broken into angular forms. They will probably be weak in handling, and will probably break up more or less readily when exposed to heat shock. Subangular grains are fractured grains which have been partly rounded, and round grains have withstood erosion or abrading movement without fracture. These characteristics have a direct bearing on the suitability of any sand reclamation system, as will be explained later.

The chemical composition of the sand grains may be of great importance. The grains suitable for foundry use must be substantially pure silica. A few other materials such as zirconium silicate offer some possibilities (in spite of their expense), but silica sand is and will probably remain the basis of foundry practice.

The sands themselves may be colored by impurities, and these impurities have a slight effect on the suitability of the sand for foundry use because they, in the main, lower the sintering point of the sand. Relatively large numbers of grains containing a considerable portion of iron oxide will not affect castings adversely unless they are subjected to intense heat for a long time, or when certain other impurities such as calcium carbonate are present.

Surface Condition

Another characteristic of sand which is important is the condition of the surface. If the sand grains are heavily pitted or very irregular in shape, they will absorb more oil or other bond to attain the required strength and other physical characteristics. (Examination of cuts will explain this.)

With the foregoing in mind, there are three general methods of producing good sand from waste sand: (1) The dry system, (2) the thermal or burning system, and (3) the wet system.

The dry system has been in use for many years and falls short in its end result. The lumps of sand are broken and the material moved with more or less agitation through a series of screens and through a column of moving air, the velocity of which is adjusted to throw off the dust.

The process serves admirably to open up tight sand, and it has permitted an overall saving of considerable importance. The resulting product is generally not usable where rebonding must be done with oil, and has not generally been successful as a substitute for new silica sand, either naturally bonded or washed.

One of the weaknesses of the dry system has been the amount of wasting. Currents of air cannot differentiate between clay and sand and, in order to remove a substantial proportion of the clay, relatively large percentages of silica fines are removed. In one case which came under observation, this percentage of removal into dust collectors amounted to about 30 per cent of the total weight processed, and relatively large additions of silica flour or float sand had to be made to prevent penetration.

Thermal Process

The thermal process relies for its effectiveness on volatilizing or burning the carbonaceous materials, that is, residual oil and carbon, including various washes which have coated the sand. This system was described by Hartley* in 1943. The sand is, in general, brought up to temperatures above 1000° F., the volatile matter burned off, and any clay particles or dust removed by air separation from the end product. The sand is then cooled and re-used.

The third method will be gone into in more detail. It is essentially a process of wetting down core and molding sand, breaking down the lumps in a wet crusher, scrubbing this sand by pumping or by additional means when necessary, classifying out the dirt and undesirable fine material to reproduce a sand of

*W. L. Hartley, "Thermal Process of Core Sand Reclamation," TRANSACTIONS, American Foundrymen's Association, vol. 51, pp. 207-209 (1943).

GRAY IRON SAND RECLAMATION

(All photographs at 15x; enlarged to approximately 30x)

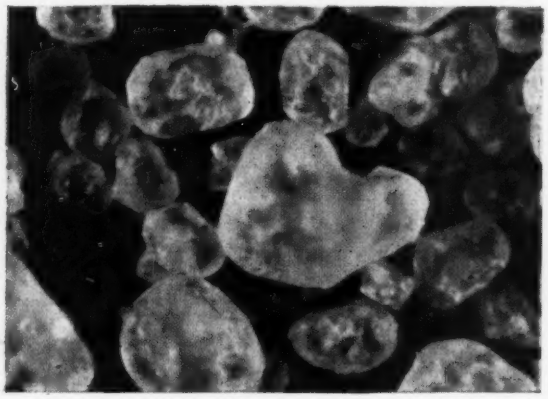


Fig. 5—New sand.

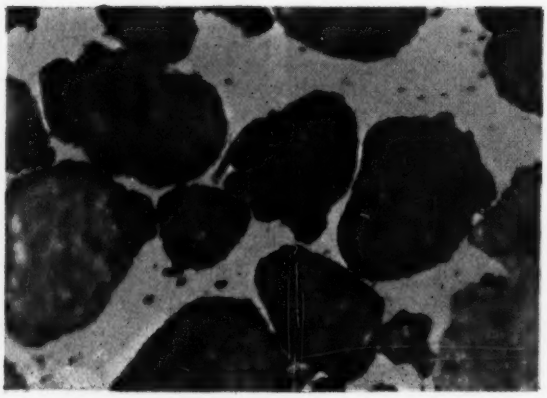


Fig. 6—Discard sand (used).

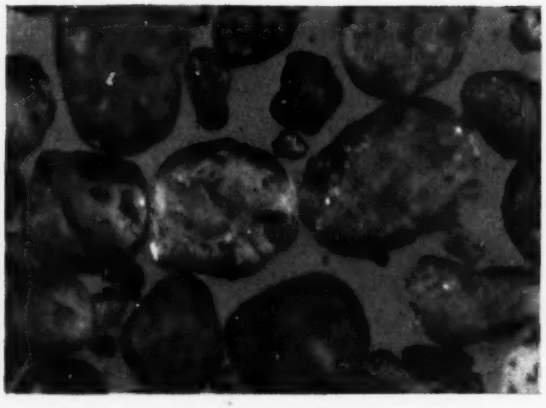


Fig. 7—Sand as reclaimed.

NON-FERROUS SAND RECLAMATION

(All photographs at 15x; enlarged to approximately 30x)

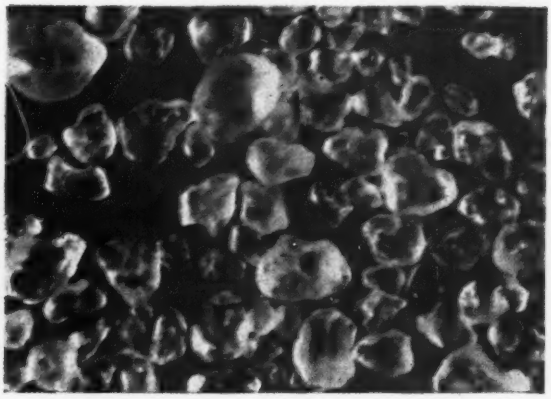


Fig. 8—New magnesium sand.

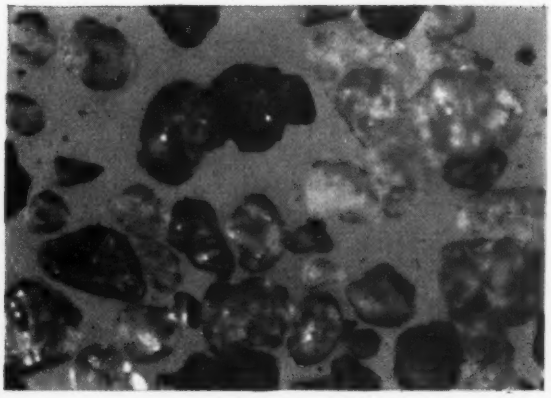


Fig. 9—Discard magnesium sand (used).

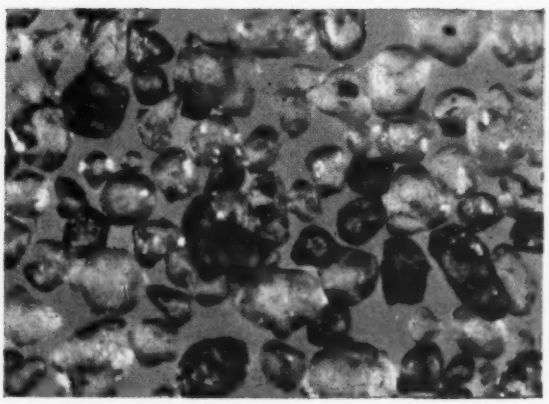


Fig. 10—Magnesium sand as reclaimed.

STEEL SAND RECLAMATION

(All photographs at 15x; enlarged to approximately 30x)

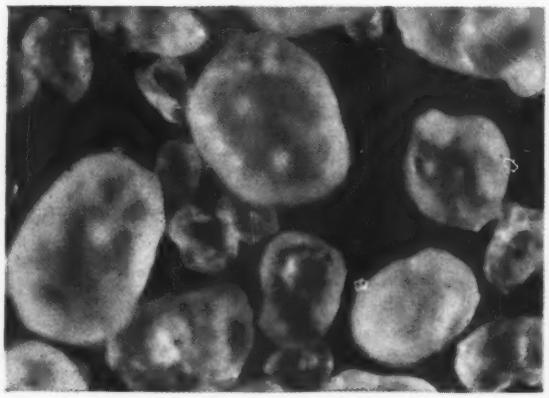


Fig. 11—New sand.

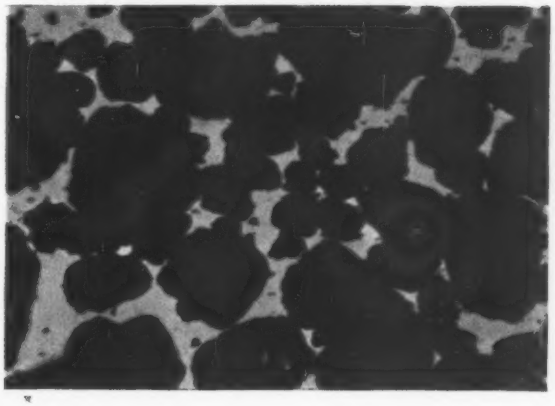


Fig. 12—Discard sand (used).

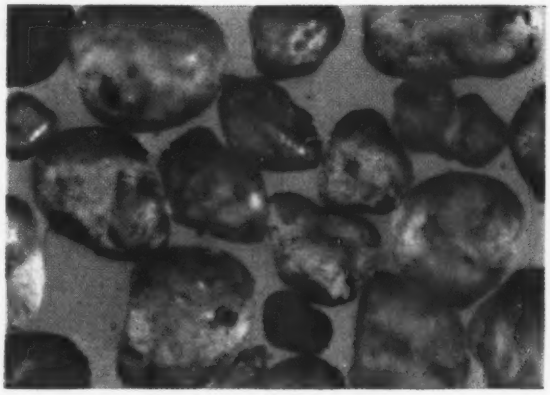


Fig. 13—Sand as reclaimed.

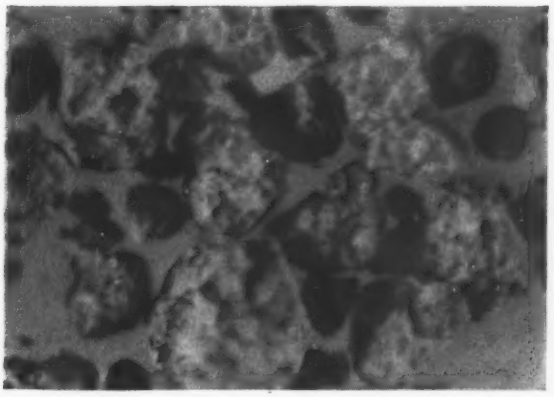


Fig. 14—Used sand ignited to show residue.

These color plates of sand were not prepared with the intention of showing true color but rather to escape certain limitations imposed by black-and-white photographs. Most of the bluish cast, even in the new sand, is misleading, as comparison with the black-and-white photographs will show. Color slides of sand projected on the screen are somewhat more satisfactory.

Typical sands for steel, gray iron and light metals were selected for 5-ton runs in a 3-ton-per-hour pilot plant. In one case (Fig. 14), the spent sand was ignited to show in an exaggerated manner the product resulting from burning a heavily bonded sand. This does not represent the product of any well-engineered thermal process. Pastel shades of color from light metal sands (Fig. 9) are the result of dyeing cores with analine dyes.

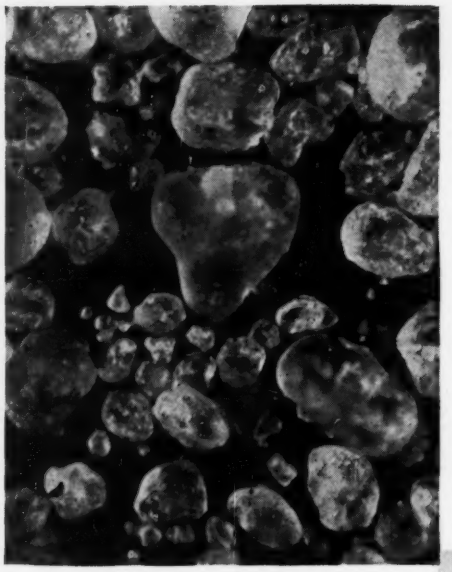


Fig. 2—New gray iron sand, 40x. Same sand as shown in color in Fig. 5. (Reduced one-third for reproduction.)

the grain size and distribution desired, dewatering and drying.

No particular details of the system itself are included in this paper, and the process is described only insofar as it will clarify thought on the end result. Work on this process was begun in an orderly manner before 1935, and encouraging results were obtained on certain sands in 1936.

It became apparent very early that, although many people have made attempts in this field, no standards had been set up. Short of putting in a full-production installation in a going foundry, there seemed to be no way of telling whether any given product was suitable for re-use.

Wet System Installation

A full-scale installation was eventually put in and operated successfully.* However, it told much less than was expected. It merely proved that, with that particular practice and with those particular castings, the sand was satisfactory. This first attempt was made in a steel foundry in which approximately 15 tons of sand an hour pumped against rather excessive heads producing a scrubbing action, and the sand then classified, dewatered and dried. Much credit must be given this foundry for its pioneering courage.

After a somewhat extended period of incredulity, another foundry making steel castings of much greater variety and with a somewhat different sand put in a system operating at 5 tons an hour. The yields of recovery in both cases were better than 85 per cent of the possible yield.

Both of these foundries used bentonite, and some of the sand treated had been bonded with oil, but the percentage of oil-bonded sand was relatively small and no conclusions could be based on those results for

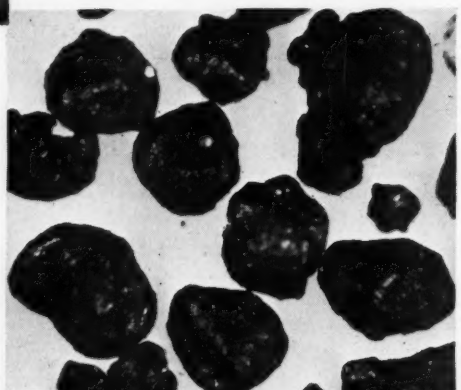


Fig. 3—Discard gray iron sand, 40x. Same sand as shown in color in Fig. 6. (Reduced one-third for reproduction.)

sands bonded essentially with oil, with pitch or with resins of various types. Sand from both of these foundries was suitable for making oil sand cores where they were needed, and there was no essential difficulty in providing sand suitable for making a small proportion of oil sand cores in these two installations.

It became apparent long before the second system was in operation that a great deal of work would have to be done on the determination of standards and means of measurement, particularly of cleanliness. How clean is clean for any given purpose?

At this moment a large company had under contemplation a new foundry in which it was proposed to include a sand recovery system of some sort. The development of the wet reclamation process had arrived at a point where the results could be of some assistance, and a long series of tests were carried out in the company's and author's laboratories, using the same oil, the same sands, the same methods of ramming and of baking.

A great variety of scrubbing means were explored in this connection, but for the purposes of measuring the cleanliness of foundry sands in steel and gray iron, a comparison of tensile strengths of new sand, of approximately the grain size and distribution, with the recovered sand proved to be a satisfactory index.

There are other important criteria. One of the possible significant measurements is permeability. The permeability of the treated sand is generally slightly higher than the permeability of new sand. This may result from the presence of a number of smaller particles in the new sand, chiefly organic matter or certain surface adhesions, usually iron oxide.

Any reclamation process tends to eliminate fine material, but there is no reason why these fines cannot be recovered also if it is worth while. Experiments now are being conducted with the recovery of silica flour and silica fines of below 140

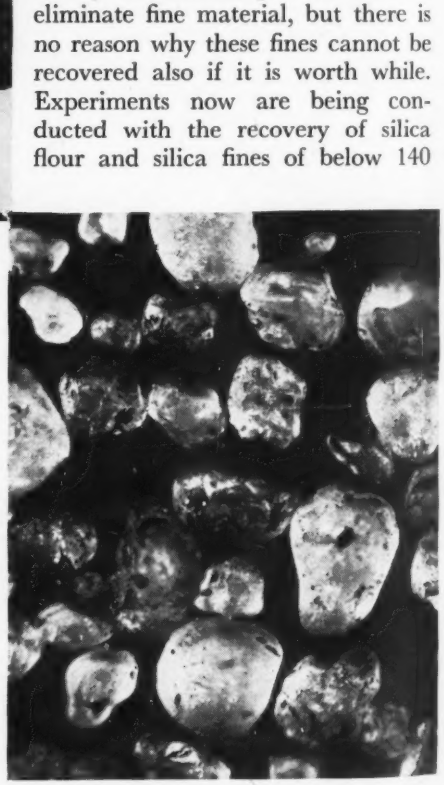


Fig. 4—Reclaimed gray iron sand. 40x. Same sand as shown in color in Fig. 7. (Reduced one-third for reproduction.)

*Howard Mason, "Steel Sand Preparation by the Wet Method," TRANSACTIONS, American Foundrymen's Association, vol. 49, pp. 1115-1131 (1941).

mesh from the clay and bentonite sludge in a steel foundry.

A separate system sometimes is desirable because these fine materials are generally used in facing and should not be distributed throughout the sand. Some permeability aspects in connection with classification will be brought out in another paragraph.

Sand Flowability

Another characteristic of sand which might be examined is flowability. This subject has aroused so much discussion and contradiction that no special point is made of this measurement at this time. However, it might be said that reclaimed sands, with any core blower or when using a slinger or any of the various molding machines, have not yet shown any marked variation in behavior from that encountered when using new sand.

Of very much greater importance than permeability or flowability is loss on ignition and gas evolution. Gas evolution measures the quantity of gas evolved when the specimen is heated to a temperature of 1800° F. Loss on ignition is merely loss in weight upon ignition.

Gas evolution is primarily important in sands used for the light metals and other alloys. Certain additions to the sand for these metals tend to produce gases in rather large quantity, and sands should, therefore, be as free from gas as is practicable in order to minimize as far as possible the danger of blowbacks, etc.

Cleanliness of Sand

The final test of cleanliness is frequently overlooked. It is a study under a relatively low-powered microscope. The character of the surface, the percentage of each surface shown to be absolutely clean and the color of the residual material will, after a little experience, give important information.

The actual color of the pile of sand is of relatively little importance. With proper characteristics it could be yellow or green or blue, and no one would care so long as good castings could be made by using it.

A number of other indications will serve as indices to cleanliness. If the sand is readily dewatered the surface of the sand grains is free from absorbent material. The ease with which the sand will "wet out" in water is likewise quite significant.

In practical experience, it may be said that where reclaimed sand has been used successfully in making castings, this sand had a tensile strength, under conditions previously described, substantially equivalent to that of new sand of the same grain size and distribution, and that the gas evolution showed little if any increase. Until there is full evidence to the contrary, it will be assumed that the tensile strength is of prime importance only where certain types of bond are used. In the manufacture of light metal castings or in cases where the oil is not exposed to sufficient heat for a long enough time to burn itself out, tensile strength is a factor.

In the latter case a gummy residue, unless removed, may actually increase the tensile strength. In such cases, of course, the gas evolution would show a startling increase.

Cleaning Sand Grains

As to the method of cleaning the grains, several factors should be noted. Many types of sand, particularly those bonded primarily with clay or bentonite, are readily scrubbed and are usually sufficiently free from dead bond on the surface of the individual sand grains after controlled pumping and classifying. Within rather narrow limits, the efficiency of the abrasive pumps as scrubbers may be increased by artificially increasing the head and the speed of the rotor in the pump. If this is carried to a great extreme, the pump will wear out unduly.

It was found, for example, in an orderly determination that a difficult sand could be cleaned adequately by pumping 19 times against a head of 100 feet. This could be accomplished, of course, by pumping in a circuit and bleeding off a suitable proportion of the material as a finished product.

From an engineering standpoint, exaggerated treatment in a pump is unsatisfactory, and the pumps should be considered primarily as a convenient means of conveying and only incidentally as sand scrubbers. In the pumps, as in other forms of scrubbing devices, round grains are easier to clean than subangular sands, and subangular sands are easier to clean than angular sands.

In the process employed for these tests, scrubbing is accomplished by the action of one sand grain upon another. It is a kind of kneading action done with controlled moisture content to give a minimum of breakdown and maximum of rubbing. The sand grains thus freed of the bond material will fall through a rising column of water of suitable velocity and the fine material will be carried away. The subject of classification, in itself, offers material for almost unlimited discussion but only the following remarks will be made.

Classification Limits

Classification is a phenomenon dependent on surface tension of the medium and density of the solids. However, the density becomes less important as the materials become finer and their proportion of area to mass increases, as shown in Table 1.

It is fortunate that the practical limits of simple water classification lie rather closely within the limits of sands generally used in foundries. It is fairly easy, for example, to produce a sand free from material below 140 mesh or below 120 mesh

Table 1

RELATION OF SURFACE AREA TO SCREEN SIZE
(Area of Sphere = πD^2)

Screen No.	*Opening, in.*	*Area per Grain, sq. in.*	*Grains per Cu. In.*	*Area per Cu. In., sq. in.*
6	.131			
12	.065	.05388	443	23.6
20	.0328	.01326	3,630	48.2
30	.0232	.00336	28,400	95.4
40	.0164	.00169	79,000	133.5
50	.0116	.00084	226,000	188.0
70	.0082	.00042	620,000	260.5
100	.0058	.00021	1,810,000	380.0
140	.0041	.00010	5,100,000	510.0
200	.0029	.00005	14,500,000	725.0
270	.0021	.00003	41,000,000	1,230.0
Pan		.00001	108,000,000	1,490.0

Table 2

COMPARISON OF NEW AND RECLAIMED CORE SANDS

Screen No.	Steel Sand — Discard, per cent Retained	Steel Sand — New, per cent Retained	Steel Sand — Reclaimed, per cent Retained	Gray Iron Sand — Discard, per cent Retained	Gray Iron Sand — New, per cent Retained	Gray Iron Sand — Reclaimed, per cent Retained	Non-Ferrous Sand — Discard, per cent Retained	Non-Ferrous Sand — New, per cent Retained	Non-Ferrous Sand — Reclaimed, per cent Retained
6	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
12	0.04	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00
20	0.08	0.04	0.04	6.70	0.10	0.00	0.04	0.00	0.12
30	2.90	2.36	2.70	5.44	0.66	0.74	0.20	0.02	0.16
40	32.96	25.80	37.80	12.82	9.20	7.02	4.16	1.46	3.76
50	32.80	35.24	41.40	41.26	49.80	43.00	44.56	43.44	49.26
70	11.10	17.22	13.64	20.26	22.24	29.58	36.00	44.20	36.80
100	5.10	10.46	3.70	5.66	6.34	9.54	11.02	10.26	8.78
140	2.60	4.36		4.02	6.78	6.64	2.00		1.00
200	1.34	1.50	0.30	1.74	4.18	2.86	0.40	0.46	0.10
270	*1.50	0.34	*	0.22	0.42	0.40	0.10	*	*0.02
Pan	*	0.46		0.24	0.02	0.20	0.02		*
Clay	9.56	1.60	0.20	0.36	0.18	0.00	1.50	0.16	0.00
Total	99.98	99.88	99.78	99.98	99.92	99.98	100.00	100.00	100.00
Physical Tests†									
Green Permeability	75	128	287	88	119	119	110	128	134
Dry Permeability	115	178	358	104	138	140	125	143	149
Flowability	76	90	91	85	88	89	92	92	92
Avge. Tensile Strength, psi.	26.5	158.0	171.0	5.0	225.5	236.0	136.0	169.5	177.5
Loss on Ignition, per cent	2.05	0.38	0.25	3.1	0.98	0.90	0.58	0.10	0.18
Gas Evolution @ 1850° F., cc per gram	8.8	1.6	0.0	10.5	1.4	2.0	15.0	0.0	2.0

†Oil to Sand Ratio: 90 to 1 (by weight). All tests made in accordance with A.F.A. Standards.
*Indicate total grains remaining on sieve nos. within the brackets.

or below 100 and 70 mesh, whereas it is quite difficult to make a separation between 400 and 500 mesh material. The problem then becomes an engineering problem of classifying and dewatering and finally drying the sand grains.

Table 1 is wholly theoretical and is based on spheres all of one size, but it serves to show some facts about classification as well as some facts about rebonding core sands.

The same characteristics that modify and limit wet classification are true in a somewhat different range with air separation. It is the surface tension of the air which makes fine particles float, the primary difference being that air is compressible and it changes its density rather rapidly with temperature changes, whereas water is relatively incompressible and the changes in viscosity up to the boiling point are not great enough to affect classification for our purposes to any practical degree.

Comparisons of Sands

Attention is called to Table 2 showing comparisons of the screen analysis of new and reclaimed sands together with the other records considered essential for comparison. One of these is from a steel foundry, one from a gray iron foundry making large miscellaneous castings, one from a gray iron production foundry using oil-bonded cores which burn out, and one from a magnesium foundry.

Photographs in color of a few of these characteristic sands, processed chiefly by the wet method, are shown. One or two photographs show, in a rather exaggerated way, some of the characteristics which limit the burning process (Figs. 5 through 14, pp. 52-53).

Steel Foundry Sand

Data are available in some detail on a number of commercial operations in steel foundries. One foundry produced slightly over 52,000 tons of castings and used the equivalent of 2½ tons of new sand per ton of castings produced, or approximately 125,000 tons of sand in somewhat less than a year. Another instance shows the washing and use of approximately 100,000 tons of washed sand during 3½ years. Another foundry has used this sand satisfactorily at the rate of 35 tons per day for 3 years, making a total of 27,300 tons.

From five other plants, complete data are not yet available, although we understand that there is a paper in preparation which analyses the economies made by the use of sand at $12 a ton with a reclamation system as contrasted with sand at $2 a ton without reclamation.

A summary of what might be reasonably expected of a wet sand recovery system may be of interest.

1. The color will not usually match that of new sand. It may be gray. This grayness is the result of small amounts of black carbonaceous material lying in the cavities or the surface of the sand grain and which cannot be readily and economically removed by the process of wet scrubbing the sand grains.

2. Grain size and distribution of the sand may be controlled within limits. These limits are determined by the grain size and distribution of the sand put into the system. Larger sand grains may be screened off at the beginning of the process and classifiers may be adjusted to remove fine material.

Water Separation

In some instances it is practicable to make a water separation of two or more classes of sand which will lie on coarser or finer screens. Such a division of sand is difficult, chiefly as an engineering problem, because it may involve duplication of dewatering and drying equipment or the successive treatment in the same equipment, first of one class of sand and then the other.

3. Cleanliness of sand, apart from color, can be determined by physical characteristics, as previously described.

4. Tensile strength should be sub-

A sand reclamation unit installed in one of the country's largest war plants.

stantially equal to that of the equivalent new sand.

5. Sintering point will not be reduced.

6. Moisture content will be controlled to a close degree.

7. The temperature of the dried sand will be constant at a useful temperature.

8. The sand will be usable in molding machines, core blowers and slingers.

9. The baking time of cores will probably be different from that of new sand, but should be within a practicable range.

10. Sand when tempered should not dry out too readily. In this connection, the scrubbed sand will often tend to dry out more readily than new sand because it contains less organic material. This can be remedied by the addition of minute amounts of clay.

11. The hardness of the cores made from sand reclaimed mechanically should be sufficient.

12. The sand will require no more bond, particularly bond of the gas producing varieties, than was required for new sand and should, of course, not require any more from the point of view of economy. It may also be expected that a wet sand reclamation system will continuously remove and discard the weak and cracked grains.

This paper has not made any point of the effect of a wet sand reclamation system on dust control. It certainly offers advantages in this direction. The dust producing grains are largely taken off in the waste from the classifiers as slimes, the action paralleling to some degree that of wet dust collecting systems which may and, in fact, frequently do use common disposal tanks and other apparatus.

Acknowledgments

Thanks are extended to Eastman Kodak Co. for the painstaking work on the reproduction of color slides; to the Cincinnati Milling Machine Co.; and particularly to H. M. Rishel and C. H. Walcher of American Steel Foundries, as well as to the 100 or more progressive foundry superintendents who have shipped us their sands for study, in many cases making castings with the resulting material. Reference also is made to J. G. Pearce, of the British Cast Iron Research Association, to Mr. Buchanan, of Glasgow, to Charles Shaffer, and particularly to the stimulating incredulity of some other foundrymen whose attitude urged us to greater efforts.

Mathieson Plant Will Increase Gas in South

THE completion of a $400,000 addition to Mathieson's Saltville carbon dioxide plant, will provide a substantial increase in the amount of dry ice and carbonic gas available to users throughout the South and Southwest. The new addition consists of two units.

Past President Miles Passes Away in Buffalo

HENRY D. MILES, A.F.A. Past President and Chairman of the Board, Buffalo Foundry & Machine Co., Buffalo, died recently in a Buffalo hospital after a brief illness.

Mr. Miles became associated with the foundry industry in 1900 when the Buffalo Foundry & Machine Co. was organized and he was named president. Following 43 years of service he was named chairman of the board and held that position until his death.

His intense interest in the foundry industry brought him into the Association and in 1912 he was elected President, American Foundrymen's Association.

Members might remember the late Past President as he addressed the 1913 Convention in Chicago when he said: " . . . notable problems have been solved by this Association, but there is much yet to do, and we should have the will to do it and I solicit the aid of all members in the work."

Henry D. Miles

Foundation Lecture Error

By Dr. H. A. Schwartz

"IN the equation on page 19 of the Foundation Lecture as printed, I unfortunately omitted the term $\frac{1}{N^2}$, where N is Avogadro's number and equal to 6.03×10^{23}. The number 3 in this equation is actually a rounding out of $\frac{\pi^2}{3}$.

"It is regrettable that this factor which converts the gas constant R into Boltzman's constant k was omitted in the original manuscript and the error not detected in spite of numerous proof readings. This involves a correction of the number 0.366 to 0.585 $T \times 10^{-8}$."

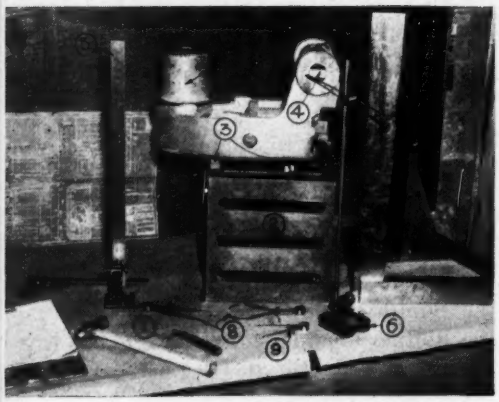


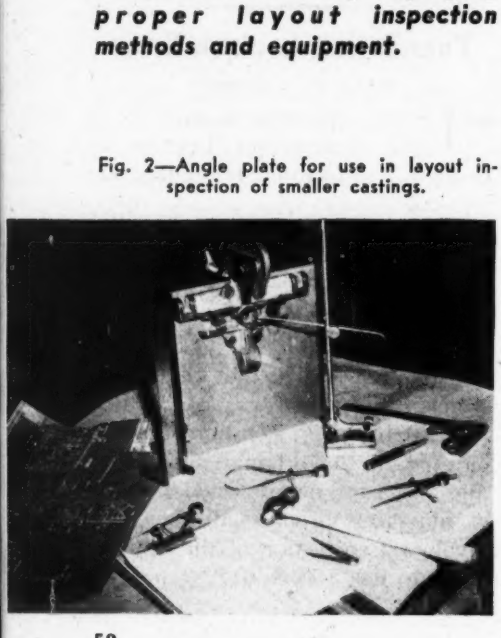
Fig. 1—Typical layout inspection setup. (1) Bracket. (2) Parallel block. (3) Wedges. (4) Wooden plugs for cored holes. (5) Scale. (6) Surface gage. (7) Center punch. (8) Inside and outside calipers. (9) Dividers.

Layout Inspection

By G. A. Dewald, Chief Inspector, Ampco Metal, Inc., Milwaukee, and A.F.A. Committee on Inspection of Castings

• *Losses due to machining, returning and replacing dimensionally inaccurate castings may be avoided and speedy corrective measures effected by employing proper layout inspection methods and equipment.*

Fig. 2—Angle plate for use in layout inspection of smaller castings.



THE A.F.A. Inspection of Castings Committee's drive to place the American foundry business on the high plane of industrial esteem that it should be on, is in full swing. This article deals with the necessity for the foundry industry, as a whole, to back up the purchasing customer by giving him what he needs, and knowing before it is shipped to him that his requirements are met according to specifications set forth in the purchase requisition.

The Inspection of Castings Committee, at its monthly meetings, formulated a number of recommendations relative to the proper methods to be used and procedures to be followed in setting up a standard or suitable inspection department. The purpose of this paper is to point out the importance of casting layout, or a dimensional check of a casting before shipping, thus obviating the necessity of costly machine work being done by the customers before finding that the casting does not clean up due to lack of sufficent stock. On the other hand, many instances are uncovered where too much stock is allowed, the removal of which ties up costly equipment.

True, the argument may present itself that patterns are checked before being placed in the foundry, but experience has taught us that many casting failures are caused by unpredictable shrinkages, wrong gating, etc.

It is also true that in order to intelligently lay out a casting dimensionally, some information must be had on the ultimate use of the products. A blueprint is, of course, necessary, together with some information on how the casting is to be machined, in order to establish a starting point for laying out.

The modern foundry has found it necessary to have a field engineer, whose duty it is to get this information as a foundation upon which to meet his customer's requirements. He contacts his customer and sees the castings in use, and is thereby able to inform the inspectors of the critical points to be watched. This information also serves to save many castings which have slight flaws or slight out-of-tolerance dimensions which do not interfere with the ultimate use.

In setting up a layout inspection service, of major importance, of course, is the selection of a qualified layout man, one capable of interpreting blue prints and having had sufficient machine shop experience to lay out a casting intelligently. He should also be familiar to some degree with pattern shop and foundry practice. Here the information regarding the ultimate use of a casting is most necessary; also, if possible, information as to the operational routing through the machine shop, which would give the layout man the starting point from which to lay out his work.

Proper working tools and layout equipment are also a necessary requirement in order to do the job satisfactorily. The equipment should consist of a layout table of sufficient size to take the largest of the castings considered for layout, inside and outside calipers, straight edge, angle plates, master square, bevel protractor, etc.

Figure 1 shows a typical setup wherein a bracket (1) is bolted to a parallel block (2) which can be turned on all sides, enabling the layout man to measure castings from all angles.

The casting is painted with bluing or some suitable colored fluid and placed on the block, leveled by the use of wedges (3) and securely bolted to parallel blocks (2). The cored holes are blocked with wooden plugs (4) on which the operator establishes the center for cored holes by punching with center punch (7).

From these centers the relationship of finished surfaces can be measured by use of the scale (5) and surface gage (6). Lines are scribed on the rough casting showing finished casting sizes, which indicate to the operator the amount of stock available for removal to clean up the casting.

When all possible dimensions are checked in the first position, the parallel block is turned over and additional dimensions can be laid out, using the original layout lines as a basis from which to measure the new layout lines.

Inside and outside diameters are measured by the use of inside and outside calipers (8). Lines are scribed by use of the dividers (9).

At times it is necessary to change the position of the casting on the parallel block in order to reach places inaccessible in the former position. Lines should be scribed in the first position to line up the cast-

ing if moving on the block becomes necessary.

Figure 2 shows the use of the angle plate, where smaller castings can be clamped in position. Procedure is then the same as in Fig. 1.

Micrometers or any high precision measuring instruments are not necessarily required, as we are dealing with rough or unmachined castings where tolerances are not generally given in thousandths inches.

A report sheet should be made of all castings thus inspected, for reference and for customer information. These forms are generally quite simple, such as listing all important dimensions, after which the actual measurements obtained from the casting are listed.

This will show all discrepancies at a glance, to both customer and inspector, and will leave little to guess or wonder about as to the castings being within dimensional tolerances. These reports are valuable to the patternmaker when castings show some discrepancy in size, enabling him to correct the pattern without further check, and to the customer in that, without this knowledge, he must lay out the work or set it up for machining, with the possible expenditure of costly machine time before discrepancies become apparent.

If the layout proves the first casting of an order to be satisfactory, templates and gages should be furnished for all critical dimensions for quick and accurate size inspection on the production run of castings. However, good judgment must be used so that the investment in such tools may be recovered by the saving of man hours made possible by their use.

Naturally, a layout of this nature would result in a slight increase in the cost of castings. However, what purchaser of these products would not be willing to pay a small premium for the satisfaction of knowing that he is buying and getting what he wants? The extra cost is more than made up in time saved, in the elimination of useless machine work and the necessity of sending castings back to the foundry and waiting for replacements, and in numerous other savings.

• COMMITTEE REPORT

Specifications Committee Urges Joint Writings

By Chairman Carleton C. Hitchcock, R. C. Hitchcock & Sons, Minneapolis

IT is believed by the committee that the casting specifications to date are very inadequate for the inefficient operation of a foundry. With this in mind, we have arrived at some fundamental generalities which can be used as a basis for rewriting of casting specifications.

The specifications as written should confine themselves to simple, general requirements such as the analysis and mechanical property requirements. In setting up the chemical analysis limits, the tolerance should be as wide as possible and still insure an alloy that will easily meet the physical requirements.

After much discussion, it was agreed upon that the acme of relations in the purchasing of castings is personal contact between vendor and purchaser. This, however, is impossible in the case of large companies who desire to send out invitations for bids. With these two points in mind, the committee feels that a very necessary part of each drawing is a specification sheet which gives in detail the performance requirements of the part. This also should include the heat treat condition; the specific test bar requirements for the part; the x-ray requirement; surface grade; pressure tightness; welding and repair allowance. If this specification sheet is clearly written, there could be no doubt in the vendor's mind as to just what was expected of him on each casting. The fallacy of the present specifications is that the same specification is used for a snap switch cover as is used for an aircraft engine part.

We feel that a standing committee should be retained by the A.F.A. for continuous thought and work along this line. We recommend that a general specification should be written jointly by the various metal societies which would stipulate several different classifications of casting importance. In each classification would be the various degrees of inspection required for a part of that importance. This specification could be used by engineering departments thus enabling them to place their castings in the proper classification and help them in writing up the specification data sheet for each part.

We as a committee are mindful of the fact that many military applications are more severe than peace time applications, but with proper cooperation received from the services, special specifications could be written to cover these applications. This cooperation if started now would prove very valuable in facilitating the flow of castings from foundry to consumer.

Western Michigan Launches Foundry Educational Fund

DEDICATED to the memory of the late Donald J. Campbell, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich., is an educational fund which will be governed by the Western Michigan chapter. The distinguished achievements by the late Mr. Campbell in the field of science and invention which advanced the American standard of living led the A.F.A. to bestow upon him, in 1939, the W. H. McFadden Gold Medal.

The Western Michigan chapter has now established the Donald J. Campbell Educational Fund for the purpose of assisting worthy young men interested in the foundry industry to obtain a college education. Set up to consider the qualifications of a student possessing a high school education to a graduate engineer who desires post-graduate work, this fund will help educate many future foundrymen.

According to the plan, students eligible for loans to start or finish their educations may be selected by a chapter member, a firm with a Company membership or by any educational institution in the State of Michigan.

The student who qualifies for a loan and decides upon a foundry future may select any institution of learning in the State of Michigan which offers foundry or metallurgical courses.

It is felt, by both the chapter members and the trustees who govern this program, that through this fund will come new ideas and developments which will enhance the value of the foundry industry.

Fig. 1—(Right) Sink hole, 3-in. deep, in 8x40 in. corliss engine valve casting. Fig. 2—(Below) Defect was built up with 3¼ lb. of cast iron rod. After machining, the casting will be as good as new.

• Two methods of welding are available to the gray iron foundryman—fusion welding and bronze welding. Joint preparation and cooling procedures are common to both methods. Each method has its advantages for particular applications, the choice of method depending upon proper evaluation of the various factors involved—chemical composition of the cast iron—service for which the part is intended—size of the part—subsequent finishing operations—cost of the welding operation.

Welding Methods for GRAY IRON CASTINGS

By L. F. Granger,
The Linde Air Products Co.,
New York

WELDING of gray iron castings is not a new operation to the foundryman; this process has been used for more than 25 years in the gray iron foundry, for filling blowholes and building up undersized areas, and for the repair of castings broken in handling (Figs. 1 and 2). In fact, many large foundries have set up welding departments especially for doing this work.

In some instances the welding process is used for remodeling large, expensive castings when, as a result of changes in design, it is necessary to add members to the casting or to build up certain sections to provide additional strength.

Two Methods Available

The welding of cast iron is by no means confined to the foundry. In fact, this process is used throughout industry for repair and maintenance work. As practiced in the iron foundry, however, cast iron welding is done with a cast iron rod that will give a weld of about the same composition as the parent metal, and for this reason the foundryman may lose sight of the fact that two methods for welding cast iron are available, namely, the fusion method and the bronze method.

This paper will describe these methods briefly and explain the factors determining which method should be selected for a particular application. No attempt will be made to go into the details of the procedure for either method.

In the fusion welding method, a weld is made by melting the edges of cast iron pieces and filling the "V" with additional molten metal from a cast iron welding rod. Foundrymen are familiar with this method since it is used for depositing molten metal from a cast iron rod in a blowhole or other casting opening.

Bronze welding is a method of welding ferrous and non-ferrous metals with a bronze rod, rather than with a rod of the same composition as the parent metal. When cast iron is bronze welded, the base metal never actually is melted (Fig. 3). It is merely brought to a temperature high enough to cause the bronze to flow onto the surface of the base metal and bond with it.

This paper will not attempt to tell how each of these welding methods should be applied, but a brief outline of the procedures involved will serve to show the differences between the two methods.

An outline of the steps in the procedures for each method is identical, namely, joint preparation, preheating, welding, and cooling. The two methods differ markedly, how-

Fig. 3—When the cast iron frame of this paper cutoff machine was broken by an industrial truck, it was repaired in place by bronze welding.

ever, as regards preheating and welding. The differences in preheating requirements are a direct result of the differences in welding methods, which will therefore be repeated.

In the welding of cast iron with a cast iron rod, which is a true fusion method, the prepared edges of the parts to be joined must be heated to the melting temperature, and molten metal from the rod is then deposited in the "V" while its edges are in a molten condition.

In contrast to this, the base metal is not melted in bronze welding, but is merely brought to a temperature of between 1600 and 1700° F., or well below the melting point of cast iron. At this temperature, the bronze from the welding rod bonds with the surface of the base metal, forming a strong, ductile joining.

Considerably more heat is required to bring the edges of a break in an iron casting to the molten state (2050 to 2200° F.) required for fusion welding. Highly localized heat in areas not free to expand and contract is quite likely to produce excessive stresses in the work. For this reason, the general rule for fusion welding cast iron is that the entire casting should be preheated (Fig. 4) to a faint red (900 to 1050° F.) before welding. This prevents localized expansion and contraction stresses that might otherwise be sufficient to distort or crack the relatively brittle metal.

When a cast iron part is to be bronze welded, the casting should only be preheated to a black heat (800 to 900° F.) and often only in the vicinity of the break. The reason that local preheating is sufficient is that expansion and contraction stresses are greatly reduced because of the lower temperatures used in bronze welding, and because of the greater ductility of the weld metal.

Procedures Common to Both Methods

Whether a part is to be bronze welded or fusion welded, the joint preparation is usually the same (Fig. 5). The edges to be welded are beveled to form a 90° "V," with a hammer and cold chisel or on a grinding wheel. Both methods employ specially prepared fluxes to aid in controlling oxides formed during the welding operation.

The cooling procedure is likewise the same for both methods. The important factor is to protect the welded part from drafts during the cooling process; this is usually done

Fig. 4—Simple preheating furnaces for cast iron parts can be made from fire brick. The part should be supported on bricks above the bed of charcoal to assure uniform heating.

by burying small parts in dry sand, slaked lime, dry asbestos cement or some other insulating medium, or by covering large parts with asbestos paper.

The choice between these two welding methods for a particular job depends on the chemistry of the cast iron to be welded, the service for which the part is intended, and the evaluation of other factors that influence the cost of doing the work and the results expected (Fig. 6). A listing of the advantages of each method will serve to show the

Fig. 6—Cast iron sprocket on the conveyor for a paper rewinder was broken into several pieces when the slats hung up. It was quickly repaired by bronze welding.

Fig. 5—This cast iron cylinder for a hoisting engine in a coal mine, of 16-in. diameter and 1-in. thickness, froze and cracked in cold weather. Sixteen pounds of bronze rod were used in repairing it.

factors in the selection of a method.

Advantages of Fusion Welding

For all practical purposes, fusion welding is a recasting of the part being welded. The weld metal has the same color, the same composition, and the same structure as the parent metal (Fig. 7). The machining characteristics of a fusion weld are the same as those of the original cast iron throughout the weld zone.

Cast iron welding rod is considerably lower in cost than bronze welding rod. Absolute cleanliness of the surface to be welded is not as

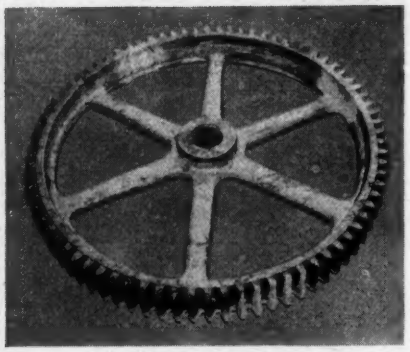


Fig. 7—The 4½-ft. bull gear for a veneer lathe was repaired by a combination of fusion welding and bronze welding. Two teeth at the 2 o'clock position were rebuilt with cast iron rod; the crack at the 11 o'clock position was bronze welded.

essential in fusion welding as it is in bronze welding.

The preheating and postheating of the entire part relieves locked-up stresses throughout, and often leaves the casting in better than original condition.

As has been brought out before, local preheating is usually sufficient for bronze welding. This advantage frequently makes it possible to make a repair in place by bronze welding, whereas it would be necessary to dismantle the machinery in order to make the same repair by fusion welding (Figs. 8 and 9).

The fact that bronze welding requires less heat than fusion welding naturally increases the speed of the joining, which, in turn, results in a decrease in time and gas consumption for a given job. Savings in time and gas offset somewhat the higher cost of the bronze rod.

The use of less heat also has other advantages, such as saving in the time required for the part to cool and less distortion of the part during the welding operation. Heat-treated surfaces are usually unaffected by the low temperature at which the bronze is deposited. The relatively high ductility of bronze weld metal permits of a slow yielding under reasonably low stresses, even at ordinary temperature, which acts to take up any slight readjustment in stresses during service.

The ease with which the welding operation can be performed is of little importance in choosing between the two methods since a skilled operator can handle either method with equal ease. In actual practice the welding operator may simply choose one method or the other according to his familiarity with it, without considering other factors.

Likewise the matter of strength need not be considered when the parts are to operate at service temperatures of under 500° F., since both methods produce welds as strong or stronger than the parent metal. Bronze loses strength at temperatures much above 500° F., and is therefore not feasible for parts which are to be raised subsequently to higher temperatures, either in service or during treatment (Figs. 10 and 11).

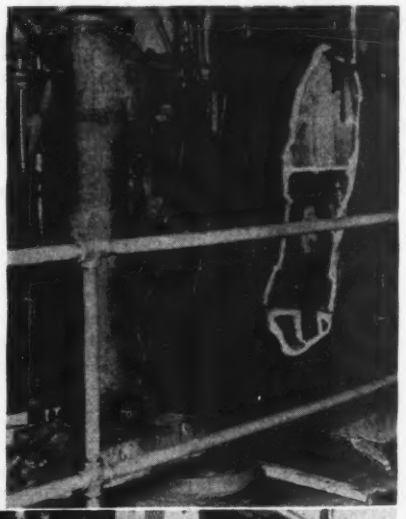
Entirely apart from the relative advantages of the two methods, one method or the other may be preferable for the job at hand because of the nature of the part or its intended use. For example, malleablized castings should always be bronze welded, and such white iron castings as might have to be reclaimed before heat treatment for conversion to malleable iron should always be fusion welded.

Also, fusion welding is the only satisfactory method of repairing "poisoned" castings such as machine parts that have become oil soaked in service, or castings that have been exposed to heat, such as boiler sections and grate bars (Fig. 12).

Fusion welding is naturally the preferred method for reclaiming defective gray iron castings in the foundry, since the properties of the weld metal must match those of the base metal. The fusion method is also desirable where the casting is to be machined, tapped, or threaded in the weld zone (Fig. 13); where uniformity of rate of expansion and contraction throughout the casting is desirable; and where the casting is to be enameled or glass coated.

Although it might seem preferable to use the bronze welding method in order to eliminate the need for preheating the entire part, careful con-

This paper was secured as part of the 1945 "Year-'Round Foundry Congress" and is sponsored by the Committee on Welding Cast Iron, Gray Iron Division, A.F.A.



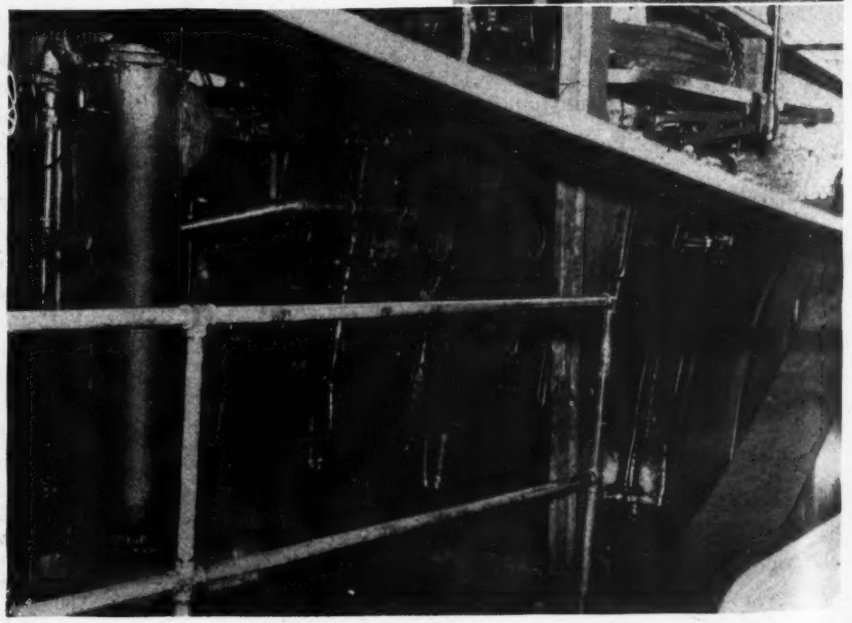
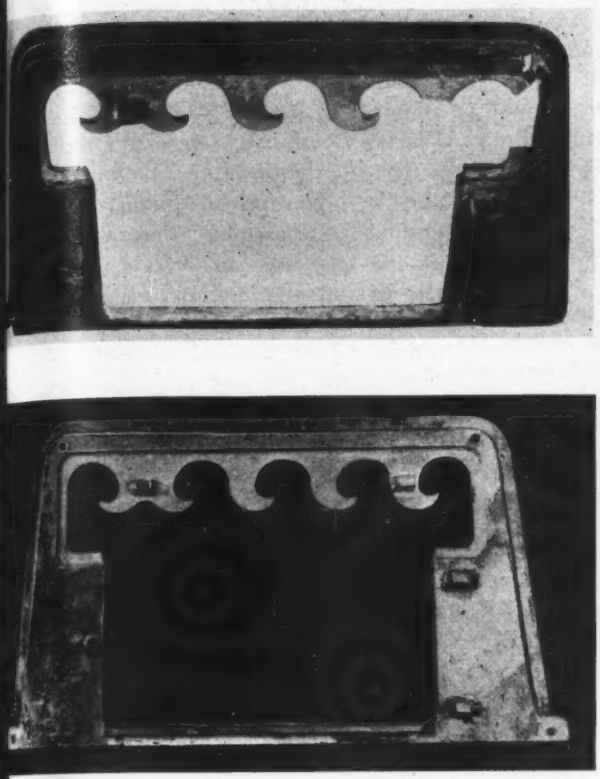


Fig. 8—(Right) The broken block for a 220-hp. diesel engine. Fig. 9—(Below) The block after it was bronze welded, using 175 lb. of bronze rod. Fusion welding would have been impractical for this repair.



Figs. 10 and 11—Cast iron fusion welding was the method selected to repair this ash-pit door for a large heating boiler (shown here before and after) because of the high temperatures to which the casting is exposed. Four different breaks can be seen in the upper illustration.

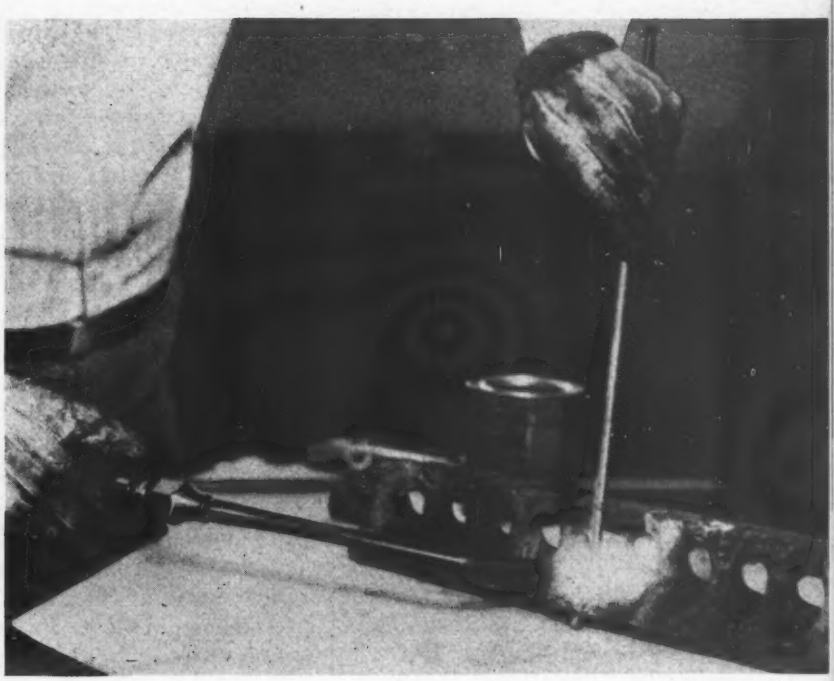


Fig. 12—Broken grate bars and other furnace and stove parts can be repaired by cast iron fusion welding.

sideration should be given to the factors just mentioned to determine if any of them make it imperative to use the fushion method.

Bronze Weld Metallurgy

Foundrymen familiar with fusion welding may wonder how a process such as bronze welding, in which actual fusion does not take place, can produce a strong joint. The basis for the bronze-welding process is that both brass and bronze will flow onto the properly prepared surfaces of higher-melting-point metals or alloys to give a bond or molecular union which has excellent properties.

Although the base metal is never actually melted in bronze welding, the unique characteristics of the bond between the bronze rod metal and the base metal are such that the results obtained are fully comparable to those obtained through fusion welding.

Bronze welding depends for its success upon conditions which will cause the molten rod metal of low surface tension to flow easily and evenly over the surface of the properly heated and chemically cleaned base metal just as water flows over a clean glass plate.

This spreading of molten metal from a bronze welding rod over a base material which is in a proper condition is known as the "tinning" of the base metal with the bronze. When the base metal is allowed to cool so that the bronze solidifies, this tinning action results in an extremely strong bond between the bronze and the base metal.

In addition to the tinning action,

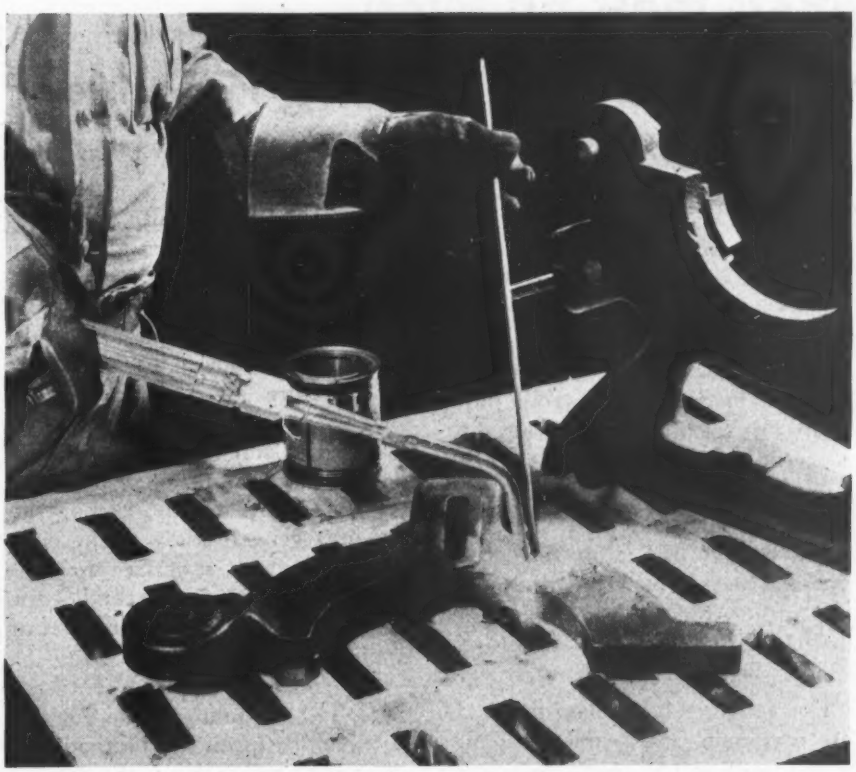


Fig. 13—This cast iron steady rest for a lathe was restored by fusion welding.

a slight interalloying of the constituents of the bronze and of the base metal will occur in a narrow zone at the interface of the bronze and base metal. This is apparently a slight reaction, not observable except under a microscope.

There also seems to be some evidence that the action of the molten bronze opens up the grain structure of the base metal to a certain extent and allows the bronze to penetrate along the grain boundaries. With cast iron as a base metal, it appears that during welding the bronze flows in to occupy the space left by the oxidation of some of the graphite flakes.

A description of the various types of cast iron is not within the scope of this paper. However, it is desirable to stress the necessity of determining what type of cast iron is to be worked on, since this may influence the selection of the welding method. A spark test, study of a freshly fractured piece, or observation of the action of the metal under the blowpipe flame are methods commonly used by welding operators to identify the type of cast iron.

In conclusion, it should be stated that there is no single standard method for welding cast iron. The decision to fusion weld or bronze weld a given cast iron part should be based on a consideration of a number of factors, including the following: (1) The type of cast iron. (2) The service conditions, including temperatures. (3) Subsequent finishing operations such as machining, painting, or enameling. (4) The size of the part to be welded. (5) Available preheating facilities. (6) The operator's familiarity with one method or the other.

Whichever method is preferred by an individual operator, the fact that two methods are available and that a judicious combining of the two methods can produce substantial economies in the repair and reclamation of iron castings should be kept in mind.

Acknowledgment

The material presented in this paper was accumulated from many sources and is largely a composite of the work and experience of the field engineers and service operators of The Linde Air Products Co.

● COMMITTEE REPORT

GRAY IRON DIVISION

Groups Active During Past Year

By Chairman C. O. Burgess, Union Carbide & Carbon Research Labs., Inc., Niagara Falls, N. Y.

THE Gray Iron Division committees of A.F.A. are primarily designed to develop fundamental information dealing with the founding, properties and fields of gray cast iron application. An attempt has been made to expand and intensify this essential work during the past year, and due primarily to the initiative of individual committee chairmen and committee members it is felt that this effort has been generally successful. The continued cooperation and encouragement of the national officers also has been of great benefit.

The activities have been directed into two main fields,—improvement in the methods of producing high quality cast irons (Cupola Research, Casting Defects, Chill Tests, Pig Iron, Shop Operation, and Inoculation Committees), and determination of engineering properties of cast iron with a view toward its greater application in industry (High Temperature Properties, Welding, and Microstructure Committees and Proposed Committee for Specification study). In this last field, the Gray Iron Division also is cooperating in a general study of the engineering properties of cast irons to facilitate the intelligent and legitimate use of cast iron in engineering applications.

As concerns improvement and wider understanding of the methods by which cast iron can be produced, the extensive work of the Cupola Research Committee is nearing completion, and, as soon as conditions permit, will be crystallized by publication of a Cupola Operation Handbook. The Analysis of Casting Defects Committee, one of the most active of the existing committees, also is preparing to publicize its findings and make basic information on the avoidance of defects generally available to foundrymen. The Chill Test Committee, as a first step toward standardizing methods of determining chilling characteristics and factors influencing the response of cast iron to a chill test, has recommended a wedge type chill block for routine work and a hatchet type for research work. In view of the rapid development of the ladle inoculation process in cast iron foundries, the Inoculation Committee has arranged a written symposium covering existing methods of inoculation, and the beneficial results both in physical properties and control of cast iron that may be anticipated from the use of suitable inoculants. The Pig Iron Committee as part of its activity has concerned itself with the problem of obtaining pig irons adapted to cast iron production, and the Shop Operation Committee has completed arrangements for courses that should prove of great practical importance when conventions are again authorized.

As to extending the application of cast iron in fields to which it is adaptable, and enhancing its value to industry in general, the Committee on High Temperature Properties of Cast Iron has done valuable work in cooperation with the A.S.T.M. and the War Metallurgy Committee. This joint work has resulted in an A.S.T.M. Tentative Specification recognizing the expanded temperature range within which modern cast irons of controlled analysis can be successfully employed. The educational work of the committee continues, and will cover non-pressure applications at elevated temperatures and the use of cast iron at subnormal temperatures. The importance of establishing information on welding characteristics and procedures, if cast iron is to enjoy the widest application, has been recognized, and the Welding Committee has actively cooperated with interested groups in setting up standard practices. Expansion in the use of

(Concluded on Page 71)

Equipment Trends in

PRECISION CASTING

• *Precision casting, as a means of producing intricate castings to close dimensional tolerances and eliminating slow and costly machining operations, has proved itself in war production. Equipment and methods developments indicate extensive post-war applications of the precision casting process.*

By Capt. A. J. Dore,

Chicago Ordnance District,

Chicago

MOST foundrymen are quite familiar with the general procedure involved in precision casting. Several excellent articles on the subject have been published by Neiman[1] and others.

Table shows an outline of the principal steps involved. The first step is the manufacture of patterns, which differ from those used in normal foundry practice because a pattern is expended for each cast made. This means that an inexpensive method must be used for the production of the patterns.

It also follows that no matter how inexpensive these patterns become, they are almost sure to cost more than the amortized cost of the single pattern used in normal foundry practice. The justification for this expense and all the other new expenses is the reduction or total elimination of machining which follows from their use.

In general, the pattern material is either wax or plastic. Wax is more common, and comes directly from the dental and jewelry practices. The plastic pattern is a new addition to the pattern family, and was introduced by industry. In general, the use of wax permits a lower initial investment, since inexpensive wax injection machines are available, whereas with plastic patterns, a plastic injection molding machine must be used.

In addition, low cost injection dies for the production of wax patterns can be made by casting a low-melting alloy around a master pattern, as compared to the high cost of making a plastic injection die.

This cast die technique for wax pattern manufacture is a direct take-off from dental practice. The first step is shown in Fig. 1*A*. A master pattern (5) is carefully placed in modeling clay to its parting line in one half of the die set. As shown in Fig. 1*B*, fusible metal (6) is poured over the master pattern to form one mold half. After cooling, the modeling clay is removed and replaced similarly with the fusible metal.

The result is a die for wax pattern production which is suitable for small production. By adding the following additional step, higher temperature alloys and pressure can be used to obtain a more durable die. This step comes between *A* and *B* (Fig. 1), and consists in filling space (6) with a hard-setting plaster material. After the plaster material has hardened (½ hr.), the die is inverted, the modeling clay removed, and molten alloy metal substituted.

Pressure is applied to the molten alloy until solidification occurs. This completes the first half of the die. The plaster material is then thoroughly removed from the pattern and the half of the die which has just been completed; their surfaces are dusted with graphite and again molten alloy is poured in and placed under pressure until solidification is complete. The die is now completed.

This type of die, while not generally recommended for the production of highly accurate parts in large quantities, does stand up remarkably well when properly supported and used.

A die for the plastic patterns is generally produced by standard toolroom methods and gives a fairly long life. Each injection with the plastic injection machine results in one or more complete patterns. This is not necessarily the case with wax patterns, due to the large shrinkage which occurs in the wax. The solution to this problem consists of molding wax inserts for the thicker sections. These are inserted cold into the appropriate position in the pattern die to reduce the shrinkage in these troublesome thick sections.

It is always necessary that great

PRECISION CASTINGS

Patternmaking		Investing	
Wax	*Plastic*	*Coated*	*Uncoated*
Master pattern	Metal die	Mix investment	Mix investment
Metal die	Injection mold	Invest	Invest and tamp
Injection mold pattern (1 or more steps)		Tamp	Tamp
Assemble	Assemble	**Drying and Heating**	
Dip Coat		*Wax*	*Plastic*
Prepare dip coat		Air dry	Air dry
Dip		Melt pattern out	Burn pattern out
Sand		Heat to casting temperature	Heat to temperature
Mounting		**Casting**	
Wax cement pattern to base (metal or rubber)		*Gravity*	*Pressure* / *Centrifugal*
Asbestos liner		Melt	Melt / Melt
Wax cement container to base		Pour	Pour / Pour
Ceramic Mixing		**Cleaning**	
Mix investment solids		Press out invested cast	
Mix investment liquids		Cut-off	
		Sandblast	
		Clean	
		Finish machine	

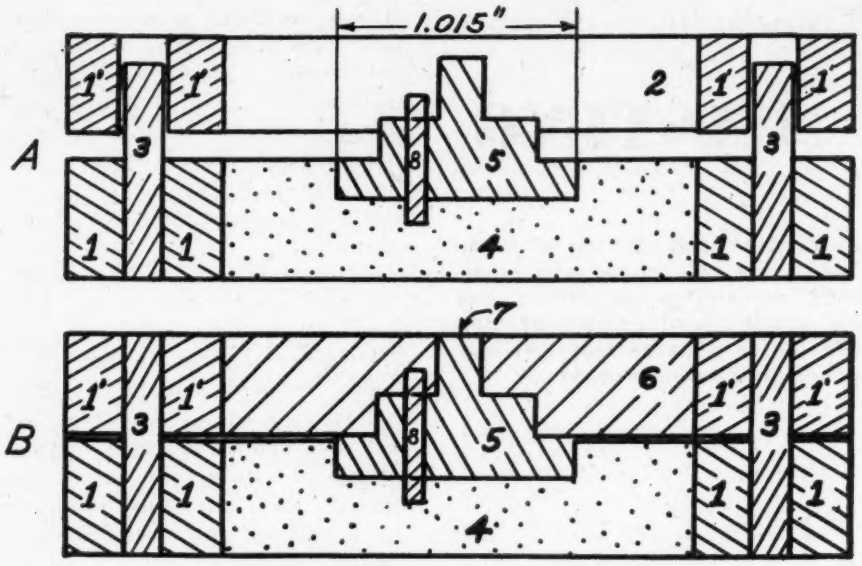


Fig. 1—Patterns used for wax pattern manufacture. Top (A)—Pattern placed in molding clay in one half of the die set. Bottom (B)—Fusible metal poured over the master pattern to form one mold half.

care be given to the placement of the feeders for the injection of the pattern material (this applies to plastic as well as to wax patterns) so as to achieve directional solidification beginning with the portions furthest from the feeder and ending with the solidification of the feeder. This reduces the tendency towards incomplete patterns which happens whenever solidification occurs first between the feeders and more remote portions of the pattern.

Figure 2 shows a production type wax injection machine. The square-shaped container in front of the operator holds the molten wax. The operator's right hand is on the hand-operated hydraulic pump which provides the die clamping pressure, and the left hand is on the die blocks. Close control of wax temperature and injection pressure is maintained.

The dies are carefully inspected for cleanliness before each operation. Any residual wax is removed by brushing with carbon tetrachloride. Figure 3 shows the operator lubricating the die prior to the injection molding operation to facilitate removal of the pattern. In front of the operator is a block of dry ice used to prevent the mold from becoming too hot.

In making plastic patterns, a standard plastic injection molding machine is in general use. The plastic powder is fed from a hopper into a heating chamber, where it is heated to a closely controlled temperature. From this chamber, the liquid plastic is automatically fed into the die with each operation. The cyclic time is controlled by the operator.

Several patterns are generally mounted on a sprue—either directly or through intermediate risers and runners such as shown in Fig. 4. Attainment of the maximum output per mold is even more necessary for investment casting than for normal foundry casting due to the high cost of the investment material. Patterns, sprue and feeders, both wax and plastic types, are cemented together by first using a heated knife or spatula to wet the mating surfaces and then holding them in contact until setting is completed.

Most manufacturers use a dip coat on the pattern and back it up with investment. This undoubtedly permits the use of a less expensive investment than would be the case without it. Coarser investment ma-

Fig. 2 (Below)—A production type wax injection machine.

Fig. 3 (Right)—Lubricating a die to ease pattern removal. Note block of dry ice for cooling die.

terials are also used, resulting in greater porosity which, in turn, cuts down the drying time for the investment.

This dip coat consists of silica flour suspended in a suitable binding liquid. The patterns are dipped into it by hand and then sanded to provide a coarse surface with which the investment can readily form a bond. They are then allowed to dry for 2 days.

After drying, the dip-coated patterns are generally mounted on a steel plate. This is accomplished by pouring hot wax on the plate to form a thin, tacky coating on which the pattern assembly is placed so as to rest on its sprue.

Some concerns have used a rubber base with a pre-formed hole, which fits snugly about the sprue instead of the metal plate. In this case, a small amount of hot wax is poured around the edge of the sprue to insure a perfect seal between the rubber and the sprue, since even a slight leakage of the investment after pouring would leave weakened areas within the investment.

A metal flask, which can withstand high temperatures, is then lined with a waterproof paper which extends about 3 in. above the top edge. This lined flask is then placed on the base (steel or rubber) plate and cemented thereto with hot wax to prevent leakage of the investment, as was the case with the junction of the rubber base and sprue.

Ceramic Mixing

The investment material in all cases consists of suitable refractories mixed with a liquid binder. The resulting investment must possess adequate strength at the pouring temperature and must not react chemically with the molten metal. This is especially important with precision castings, since no allowance is made for finish machining to remove any surface defects, whether chemical or physical. Silicon-dioxide sand, in general foundry use, is also the common solid used in precision castings. Magnesium oxide is sometimes added.

The sieve sizes of the solid materials must be closely controlled. If they were all of one large size, the voids would be too great. If the percentage of fines is too high, cracking of the investment occurs due to the surface absorption of a large quantity of binder, the high shrinkage of which causes cracks.

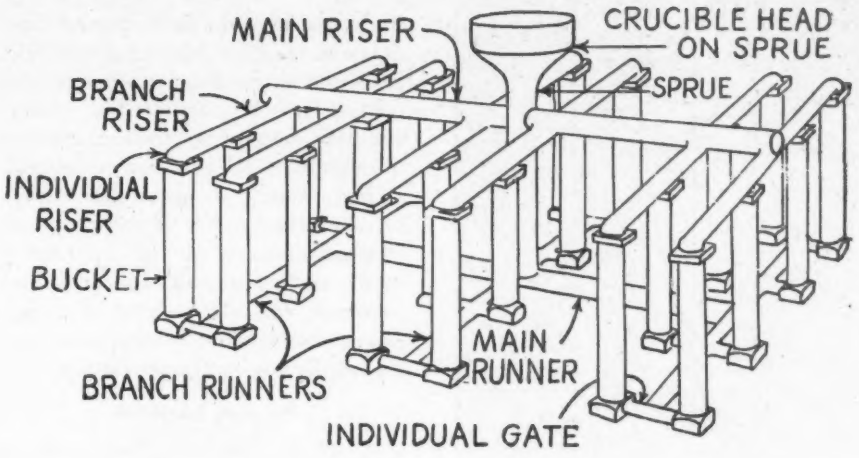


Fig. 4—Several patterns can be mounted on a sprue directly or through intermediate risers and runners.

Those manufacturers who do not use a dip coat require refractories which have a higher percentage of fines in order to achieve the same surface finish. However, since both the dip coat and the investment materials are very complex subjects and were thoroughly covered by Glaser,[2] their detailed discussion will be omitted. The actual mixing equipment required is very simple. Tumbling barrels and mullers are commonly used.

Investing the Pattern

The patterns mounted within the flask are now placed on a tamping or jogging table. The investment is slowly poured around them with a scoop while the jogging tends to eliminate air bubbles which may be entrapped in the investment as a result of either the mixing or this pouring operation.

Most of the manufacturers fill the flask plus about 3 in. of additional height; the additional height being achieved by means of the aforementioned waterproof paper liner which is around the inside of the flask. However, other manufacturers use longer flasks to start with. The jogging is continued for at least 45 min. until the solids have settled and have been closely packed around all portions of the pattern.

The flasks are allowed to rest quietly until setting is completed, whereupon the top 3 in., which extends beyond the flask, is cut off with a knife and discarded. This removes the extremely hard, dense outer surface and exposes a portion of a more permeable surface, which facilitates drying. Even with this assistance, a minimum of 8 hr. is required for drying. The base plates are now removed.

A steam table, which has openings about the size of the sprues, is used to remove the wax-type patterns. The flasks are placed on the steam table, with their sprue ends down and in line with the table openings, thus permitting the steam to melt out the wax. For all practical purposes, the steam licks the wax out, and avoids heating the entire body of wax at one time, thus eliminating the possibility of the wax pattern expanding and cracking the investment.

This differs from the procedure with plastic patterns which are burned out. With a plastic pattern, the entire mold must be heated so that it expands at the same rate as the pattern in order that investment cracks may be avoided. When the ignition temperature is reached, the plastic pattern burns. The plastic is thus a total loss.

Investment Expansion

However, the melted wax pattern is caught and can be used for sprues, runners, gates and risers. Only new wax is used for the pattern itself. The molds are then placed in an oven, still in an inverted position, that is, with the sprue end down, and very carefully brought up to pouring temperature.

The slow heating is necessary in the lower temperature range to prevent a violent evolution of the residual volatile constituents which would cause breakdowns. In the

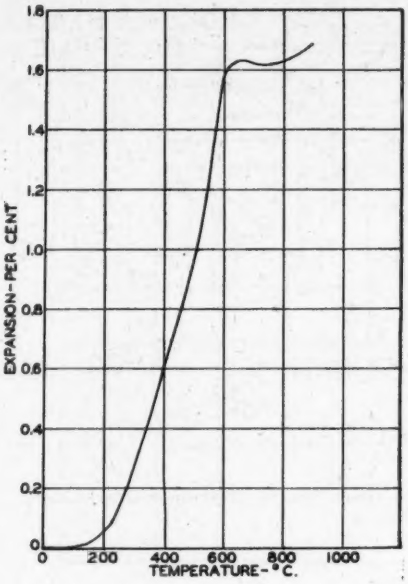


Fig. 5—An expansion curve for a silicate investment bonded with ethyl silicate.

higher temperature range, there is the problem brought up by the expansion properties of the investment.

A typical curve for a silicate investment bonded with ethyl silicate solution is shown in Fig. 5. It will be noted that the expansion is fairly constant, but high from about 392-1112° F. (200-600° C.). Between 1112 and 1472° F. (600 to 800° C.) there is an actual shrinkage of the investment. Naturally, the temperature rise through these regions must be carefully controlled if cracks are to be avoided.

Any wax not removed by the steam burns out during the early part of this heating cycle. Obviously, the final or pouring temperature depends upon the composition of the metal which is to be poured.

Some of the factors which are partially controlled by the temperature of the mold at the pouring time are allowances for the contraction of the metal from its solidification temperature to room temperature, grain size due to the amount of chill permitted, etc.

In dental and jewelry practices, it is customary to melt the casting metal by means of a gas torch. Naturally, with industrial alloys which are easily contaminated, this method has been superseded. Melting is generally done in either an arc furnace or an induction furnace.

The time per melt varies greatly with the different plants. Some manufacturers using induction melting strive to keep their melting time down to about 1 min. Such a short time undoubtedly contributes to easy control of chemistry. The supercharger plant using arc furnaces requires about 20 min. for each melt.

The metal is generally superheated 300 to 500° F. The exact amount depends on the complexity of the casting, its size, the grain size required, etc. In general, the lowest practical value is used and controlled by an optical pyrometer.

Pouring Methods

Three methods of pouring are in general use. The standard gravity head pouring, with which foundrymen are familiar; pressure casting, in which air pressure is applied to add an artificial gravity head; and finally, the centrifugal method, which is taken directly from the dental and jewelry practices.

Figure 6 shows the combination of an electric arc furnace in conjunction with pressure casting. The mold is mounted on top of the furnace with the sprue end down and lined up with the pouring mouth of the furnace. Note that the furnace is mounted on trunnions so that it can be rotated, and that the electrodes enter the furnace through these trunnions. An air-pressure connection is supplied at the bottom of the furnace.

In operation, the metal is first melted and properly superheated. The mold with furnace is then rotated about the trunnions, thus permitting molten metal to fill the mold by gravity. Air pressure is then applied through the furnace, and thus adds an artificial gravity head to the metal in the mold to achieve a dense, well-defined casting. This is the type of setup used by the supercharger plant in the production of supercharger buckets.

Centrifuging Machine

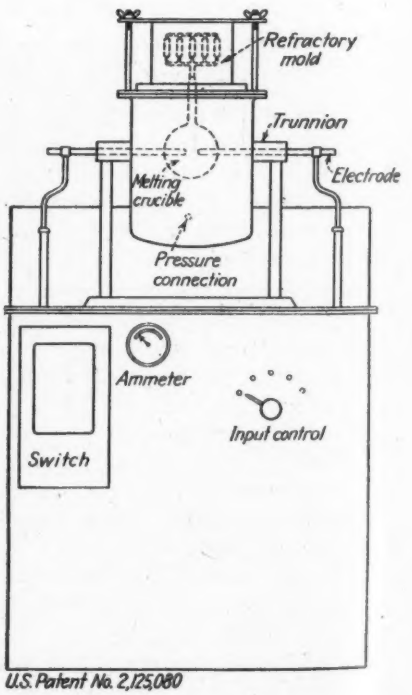
Figure 7 shows a modified dental centrifuge. The mold (7) is mounted at the extreme end of pivoted arm (11). The pouring crucible (8) is placed against the mold so that the molten metal, represented by dotted lines (13), will pour into the sprue opening due to centrifugal force when the unit is rotating. In addition, the arm (11) which holds the crucible and mold is pivotally mounted to the arm (1) which is the power driven rotating member.

Figure 7*B* shows the relative positions of the arms during the melting period just prior to centrifuging. Figure 7*C* shows the relative positions of the arms during centrifuging —the molten metal has left the crucible, entered the mold and has centrifugal force acting on the metal, as shown by arrow (5), thus giving the effect of a high pressure head.

Figure 8 shows another type of centrifuge which is somewhat akin to standard foundry centrifugal casting machines. An induction furnace is mounted on top. The centrifuge itself is completely inclosed for the protection of the operator in case of mold breakdown. When the metal is properly superheated, the furnace is tilted to pour through the center opening in the centrifuge.

Figure 9 shows the inside of the centrifuge. The center pouring cup is just below the center opening in the top of the centrifuge. Consequently, when the furnace is tilted the molten metal flows down into this pouring cup and then outward into molds which are mounted on each side. In operation, the centrifuge would be rotating rapidly prior to pouring. The design is arranged so that the pouring cup and the molds can be lifted from the preheating furnace and set in place with a pair of tongs.

Figure 10 shows the centrifuge with the pouring cup only in place.



U.S. Patent No. 2,125,080

Fig. 6—An electric arc furnace used in conjunction with pressure casting.

Note the adjustment on each side to take care of various lengths of molds.

In all cases, the metal is allowed to freeze before changing the mold conditions. In gravity casting, the mold is left untouched; in pressure casting, the pressure is maintained until solidification occurs; and in centrifugal casting, the centrifuge rotates until solidification is complete.

The invested casting is removed from the flask with a few blows from a hammer or by pressing it out on an arbor or kick press. Tapping with a hammer removes most of the investment, but a considerable part of the dip coat remains. The sprue, gates and risers are then cut off and discarded. The castings are then cleaned by sand blasting, tumbling or shot blasting. Necessary finishing, such as grinding off stems remaining from the cut-off operation, chasing threads, etc., is then performed.

Inspection has not been dealt with in this presentation, as it is a fit subject for a paper in itself—especially if x-ray inspection, as used in supercharger bucket production, is included. It is also unnecessary to give a description of the inspection equipment used in order to understand the manufacturing steps.

A more detailed examination of the equipment involved in the process may be helpful. The first step of the process, as previously discussed, is making the pattern. It might be mentioned at this time that the pattern itself is the greatest single source of dimensional variation. Figure 2 shows one of the more elaborate present day wax injection machines. Its greatest lack of control is in the temperature of the die blocks.

Figure 3 shows the dry ice which is kept near the machine, and is used to prevent the die from getting too hot when in continuous use. This is certainly a very crude arrangement, not subject to close control, and which will certainly be improved in the future. The hand-operated pump could also be readily replaced by an improved arrangement.

The same comment about lack of die temperature control applies to the plastic injection equipment. The die temperatures are not controlled and must contribute substantially to the pattern variations which are commonly encountered. For ordinary production, this undoubtedly has no significance, but for the production of precision casting patterns it will undoubtedly be good business to install temperature controls.

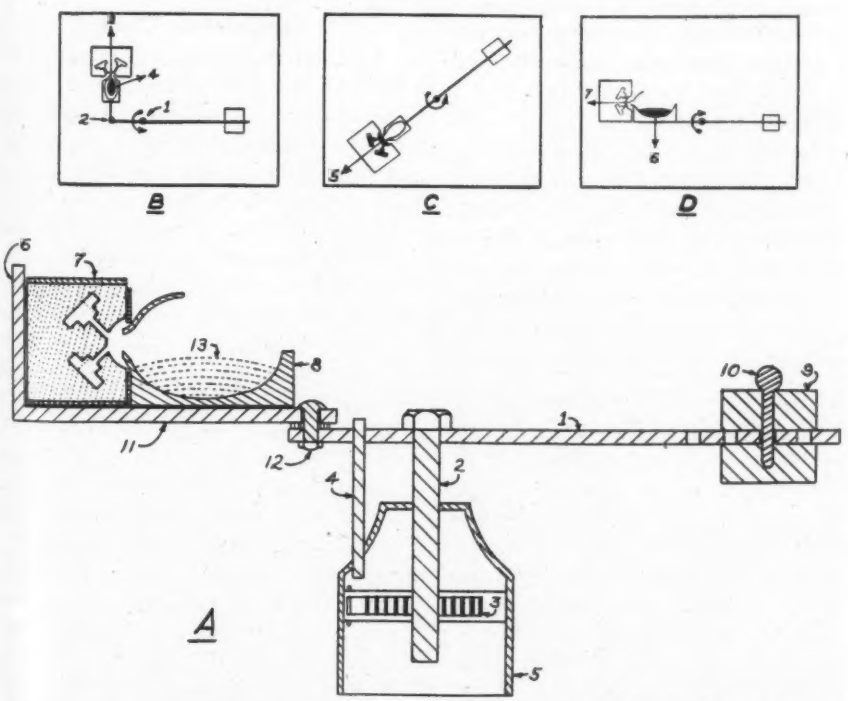


Fig. 7—Modified dental centrifuge. Mold (7) is mounted at end of pivoted arm (11). Pouring crucible (8) placed against mold (7) so that molten metal (13) will pour into sprue opening due to centrifugal force when unit is rotating. Arm (11) mounted to arm (1) which is power-driven rotating member. Fig. 7B—Relative positions of arms during melting period prior to centrifuging. Fig. 7C—Relative positions of the arms during centrifuging. Fig. 7D—Standard centrifuge.

Fig. 8—Another type centrifuge with an induction furnace mounted on top.

The development of a method for molding hollow plastic patterns is nearing completion. When completed, this method is expected to reduce the shrinkage and consequently the shrinkage variations as well as the tendency for the plastic pattern to crack the investment by expansion just prior to burn out.

Pattern Assembly

As mentioned previously, the wax or plastic patterns are assembled to the sprue, gates and risers by using a heated knife. For large production, this could certainly be made more automatic by at least positioning these components in fixtures, touching all the assembly spots in a given fixture at one time with a heated plate and then assembling mating fixtures, and thus substantially reduce the labor requirements.

The dip coat and the investment materials are presently handled without close controls. This is undoubtedly responsible for some of the rejections due to investment cracking which later occurs. For example; the sands, as supplied today, do not meet any rigid grain-size specifications. A no. 60 sand is merely a sand which has been in a ball mill for a specified time. Since the sand did not initially meet any particular specification, it is obvious that the resulting sand also will not meet any rigid specification.

This sore spot is currently handled by inspection of various sand lots, and selecting and using only those which come within the range which

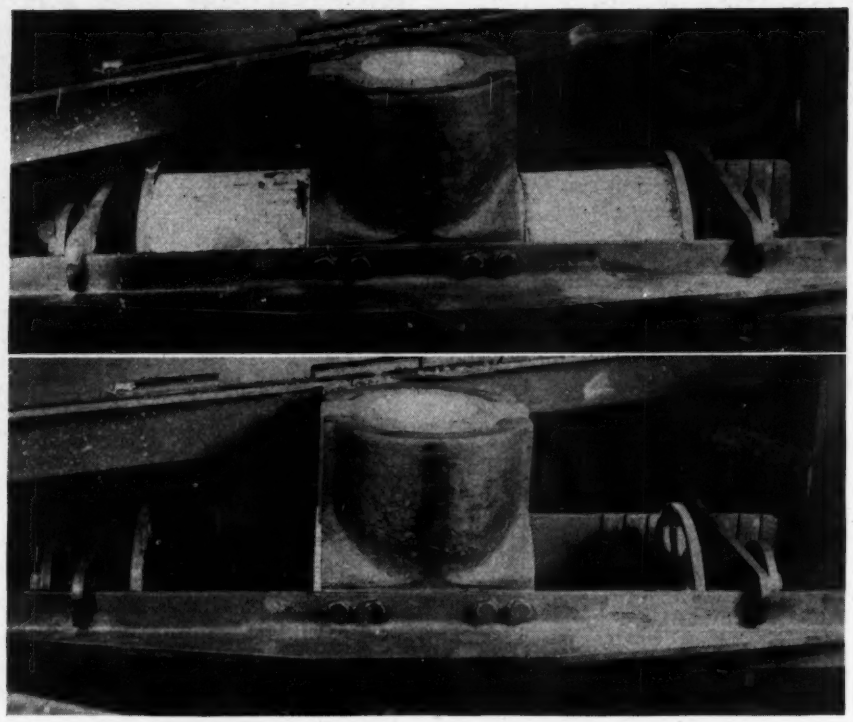


Fig. 9 (Top)—The inside of the centrifuge shown in Fig. 8. Molds on each side of pouring cup. Fig. 10 (Bottom)—Centrifuge with pouring cup in place.

is felt to be usable. Naturally, this is an unsatisfactory procedure. It would be easy to purchase sands of somewhat coarser grain sizes than that actually desired, and by the addition of finer sizes bring them to meet a fairly rigid specification.

The mixing of the investment, at least as far as the liquid additions are concerned, is left partially to the skill of the operator who, by experience, can state whether or not the right degree of consistency has been achieved. All of these operations will undoubtedly be accomplished in the near future by automatic weighing devices.

The dipping and sand spraying or hand sanding of the dip coat are hand operations whereby an operator works only on one pattern at a time. For large scale production, such as is occurring in some of the plants, automatic spray booths and the like could be worked out.

The molds are invested by hand filling, which at first sight appears to be a very backward way in this day and age. However, there are many problems involved in the handling of large quantities of the investment mixture, although none of them are believed to be insurmountable.

The function of the tamping of the investment, or jogging as it is commonly referred to in this investment field, is not completely understood. The author feels that it is not entirely a matter of compacting the investment uniformly, nor even a matter of finding a rate and amplitude which prevent segregation of the investment materials, but that a certain amount of controlled segregation has been achieved and is probably necessary.

In the top 3 in. of investment, which is cut off of the mold, many superfines are included which might otherwise cause cracking of the investment. A study from the colloidal chemistry aspect might considerably reduce the jogging time and produce a more uniform result.

Investment Centrifuging

Several patents have been issued in the dental field relating to the centrifuging of the investment itself as an improved method of settling and compacting the investment around the pattern. For industrial users, this might prove to be a more rapid method of compacting the investment and might even have some dehydrating advantages.

Pusher type furnaces are used in the larger plants for heating molds. For large scale production, a conveyor type oven would appear to be desirable, in view of the necessarily rigid time-temperature control requirements.

Another possible development in the heating line might be the use of die-electric heating, such as is currently used in the plastic industry. If it can be applied, it would permit much increased rates of heating without the accompanying risk of cracking the investment, as would occur in an unequally heated mold.

When it comes to the melting and casting end of the precision casting art, there seems to be great room for improvement, depending again upon the type of production. In fact, for research purposes, a totally new tool appears to be available, but unused so far. For example, it should be possible to induction melt and cast to close tolerances entirely within a vacuum, and thus achieve castings which are substantially free of occluded gases.

The author believes it to be entirely feasible to do this by a modified centrifugal casting technique or by modifying the pressure type setup to melt in vacuo and then allowing air to enter the furnace after the mold has been poured, thus obtaining a vacuum pressure casting. With vacuum pressure casting, the amount of air to be pumped out for any one cast could be kept to a very small amount.

Temperature Control

As stated previously, optical pyrometers are used to control the temperature of the metal. This leaves much to the judgment of the operator, prohibiting the use of unskilled help since each cast in this technique involves a separate heat of metal. It would appear worth while to develop an automatic temperature control which would initiate the pouring cycle.

Referring again to the centrifuge with a pivoted arm mounted on a rotating arm, as shown in Fig. 7. Prior to starting, the arm which mounts the mold and pouring crucible is at right angles to the arm which will cause them to rotate.

This arrangement is an improvement over the standard centrifuge (Fig. 7*D*) in that it facilitates delivering the metal into the mold by reducing the tendency for the metal to escape sidewise between the pouring crucible and the mold. However, as shown in Fig. 7*B*, the metal tends to move in the direction of arrow (4) which is still not in axial

alignment with the sprue opening and, therefore, causes unnecessary erosion of the sprue opening.

It would seem to be desirable to either move the pivot further out from the center of rotation while maintaining the mold and crucible in approximately their present position, and thus line the sprue opening up with the direction in which the metal will flow, or else to introduce a second pivot in the neighborhood of the junction of the mold and the crucible.

Where grain sizes must be fine, it would seem that automatic quenching means would be desirable. With the vitallium alloys this is unnecessary since allowing the molds to cool to about 400° F. before breaking the casting out results in the grain size which is specified and which, incidentally, is quite large. It would not be a difficult problem to provide an automatic quenching cycle for any one of the three types of casting which could be completely conveyorized.

Acknowledgment

The author wishes to acknowledge the courtesies extended by Austenal Laboratories, Inc., Chicago; Naval Research Laboratory, Washington; Whip-Mix Corp., Louisville; Allis-Chalmers Mfg. Co., Supercharger Plant, Milwaukee, and Illinois Precise Casting Co., Chicago.

References

1. Robert Neiman, "Precision Casting by the Investment Molding Process," TRANSACTIONS, American Foundrymen's Association, vol. 52, pp. 349-383 (1944).
2. Jules W. Glaser, "Refractory Molds for Precision Casting," *Iron Age*, Feb. 8, 1945, pp. 52-57.

GI FOUNDRY

Makes Thuds Out of Duds in Italy

FROM Past Chairman Earl Anderson, Southern California chapter, Enterprise Iron Works, Los Angeles, comes this interesting item of American ingenuity that concerns a former molder employed by Mr. Anderson.

The story goes that S/Sgt. John Raygoza, Walnut Park, Calif., and two other men, Cpl. Eugene Steffey, Erie, Pa., and Pfc. John W. Griffin, Aberdeen, Wash., were called upon by their commanding officer to solve a perplexing problem. Many bombs littered the heavy bomb dumps of Southern Italy, rendered unserviceable because of lost or defective bomb fin lock rings. The aforementioned men were called upon to remedy the situation.

Pouring bomb fin lock rings at an improvised foundry built by American soldiers in Italy. Note oil drum furnace in the background.

Using their initiative and all available equipment they constructed a crude foundry. Their furnace consisted of a 50 gal. oil drum cut in half, lined with fire brick and clay. The latter materials were acquired from a destroyed Italian foundry. The ladles were pounded out of aircraft armor plate; trowels, rammers and other miscellaneous implements were fabricated from scarp war materials. Salvaged propeller blades were melted down in the furnace, which was heated by oil and compressed air, and poured into molds. The bomb fin lock rings were then sent to an ordnance company for threading.

Soon the dumps of unservicable bombs became smaller and unservicable bombs turned Hitler's production area into unservicable factories.

Stories of this type make us at home feel proud that our boys are using not only the knowledge acquired while in servvice to lick the enemy but their industrial experience as well.

Gray Iron Division Report

(Continued from Page 64)

cast iron obviously depends to a very great extent on accurate knowledge of the engineering properties of various grades. As a consequence, the Gray Iron Division is actively participating in an Engineering Properties Symposium designed to define the various engineering properties of cast iron so that they may be readily utilized by designing engineers. Intimately connected with this program are the activities of the Committee on Microstructure and a proposed Committee to Study Existing Cast Iron Specifications.

The activities of various Committees of the Gray Iron Division have been listed above in some detail to indicate the intimate relation of such work to the welfare and healthy growth of the whole iron founding industry. As previously stated, credit for the progress recorded, is due to the energy and initiative of individual committee chairmen and committee members.

Proposed Engineering Bulletin and Shop Procedure for

Repairing Malleable Iron Castings

• A report by a committee of the S.A.E. War Engineering Board,* prepared at the request of Col. E. L. Cummings, Office, Chief of Ordnance—Detroit, for the use of Ordnance and industry, contains recommendations for a proposed "Engineering Bulletin and Suggested Shop Procedure" covering the repair of malleable iron castings.

PROPOSED ENGINEERING BULLETIN

I. In order to clarify "commercial practice," as interpreted by this office, and to indicate to the malleable casting producing industry and Ordnance inspectors the repairs which may be permitted in accordance with Paragraph 29 of U. S. Army Specification No. 60-0-1B, when agreed upon by Ordnance and the contractors desiring to repair castings in the above category, the contractor will submit in detail information on the practice they consider "commercial." These procedures covering the repair of defective malleable castings will be considered by this office provided the procedures include, where applicable:

A. A list of all castings on which the authority to make repairs of defects is requested.

B. For the repair of minor defects (as defined in Paragraph III) this list will include part number, part name, proposed method of repair, and marked prints showing prohibited areas, when such exist.

C. For the repair of major defects (as defined in Paragraph III), individual repair procedures will be submitted.

D. When an individual repair procedure is submitted, it shall include either a marked blueprint, marked photograph, or marked casting of each part number on which authority to make repairs of defects is requested. Said diagrams, prints, photographs or castings shall have indicated upon them those areas where repairs may be made, and the types and extents of repairs permitted. This information will be furnished by the prime contractor with the cooperation of all concerned, and must be submitted through the Army Inspector of Ordnance at prime contractor.

Sufficient diagrams, prints, photographs or castings marked as outlined above will be furnished so that copies will be available for the prime contractor, Army Inspector of Ordnance at prime contractor, District Ordnance Office where prime contractor is located, local Ordnance District where repairs are to be made, and two copies to this office (SPOME-E-OCO-D).

E. Where several repair methods (welding and plugging; welding and sealing) are desired to be used on any one casting, one or several diagrams, blueprints, photographs, or castings may be marked with different colors to signify the areas where the several repair methods may be used. This will enable one set of diagrams, prints, etc., to cover all the repairs permissible on a given casting. The code shown in Table will apply.

F. Details of proposed repair procedure include:

1. For welded repairs:

(a) Approximate composition and condition of casting.

(b) Method of preparation for welding, i.e., chipping, drilling, filing, grinding, etc.

(c) Welding process, i.e., metal arc, oxyacetylene, hot or cold, etc.

(d) Type and make of rod or electrode, including composition.

(e) Type and make of flux.

(f) Method and degree of preheat.

(g) Method of control, i.e., temperature indicating paints, crayons or pellets, low melting alloy, contact and optical pyrometers, etc., and temperature at which welding will be discontinued upon cooling.

(h) Method and degree of post heat.

(i) Method of cooling.

2. For high and low temperature brazing and soldering:

(a) Method of preparation, i.e., grinding, filing, machining, etc.

(b) Method of heating, i.e., oxyacetylene torch, etc.

(c) Type and make of solder or spelter, including composition.

(d) Type and make of flux.

(e) Type and degree of preheat, if used.

(f) Method of cooling.

3. For plug, sleeve, or bushing repairs:

(a) Method of machining out defect, with sketch.

*A.F.A. was represented on the committee which formulated these recommendations, by F. J. Walls, International Nickel Co., Inc., Detroit, and Vice-President (now President) of A.F.A.

(b) Material of which plug, sleeves, or bushing is made.

(c) Method of assembly, i.e., dry press fit, wrench assembly with sealer, etc.

(d) Type and make of sealer.

4. For peening repairs:

(a) Type of power tool used, with operating conditions.

(b) Sketch of peening tool nose.

(c) Method of operation.

5. For sealing repairs:

(a) Type and make of sealer.

(b) Method of application with sketches or photographs and operating conditions, i.e., positions, pressure, time, etc.

(c) Method of curing, i.e., type oven, time, temperature, etc.

6. For rusting repairs:

(a) Composition of rusting bath, i.e., per cent sal-ammoniac, etc.

(b) Method of application, including position, pressure and time; with sketch or photograph of set-up.

G. Detailed information regarding testing method used to check acceptability of completed repair, and repaired casting.

H. When requested by Ordnance, for welded or brazed repairs of major defects, a macrograph of a cross-section of a typical repair, with hardness survey, showing base material, heat affected zones and weld.

I. When requested by Ordnance, for plugged, sleeve, bushed or peened repairs, a photograph of a cross-section showing a typical repair portion with the exact kind of repair.

II. When agreed upon between Ordnance and the facilities, records of typical repairs will be kept by facilities which will include quantity, part number, part name, and type of repair; such records to be available to the Army Inspector of Ordnance.

III. Definition of Defects

The extent of the defect must first be determined before it can be judged whether or not the defect is repairable. The type of defect is not imporant except as it governs the extent and type of the repair to be made.

A. Minor Defects: Defects shall be considered minor when the depth of the defect, after preparation for repair, does not exceed one-third (⅓) of the actual section thickness at the point, or points of defect, but in no case is greater than one-half (½) in. The maximum dimension of the prepared defect shall not exceed twice the section thickness at the point, or points of defect, and in no case shall the area of the prepared defect exceed one square inch.

B. Major Defects: Defects beyond the category of those outlined in Paragraph III A shall be considered as major defects, and shall be repaired only when the defects, if properly repaired according to the Shop Procedure, are judged not to affect the use or machinability of the castings.

Mechanical repairs, peening repairs, sealing repairs and rusting repairs, shall be considered in all cases as repairs of major defects.

IV. Matters of Information Regarding Repairs

A. No repairs of any sort shall be made solely for purposes of improving surface appearance.

B. After a procedure has been approved, no repairs shall be made other than those provided for in the approved casting repair procedure, except by written permission obtained from the Army Inspector of Ordnance after clearance with OCO-D.

C. The attached paper entitled "Shop Procedure for Repairing Imperfections in New Malleable Iron Castings" was prepared by the Committee on Malleable Iron Casting Repairs of the S.A.E. War Engineering Board.

The information in the attached paper may be used as a general guide as to types and extent of repairs that will be considered, in preparing requests to be submitted for approval under this bulletin.

D. The intent of this bulletin is one of clarification intended *to assist* production by standardizing engineering and inspection opinions. With this in view, the cooperation of all concerned will be greatly appreciated.

V. The Approved Repair Procedure issued as a result of consideration given to the request outlined above will be for the guidance of Ordnance Inspection personnel and of indefinite duration. There is no necessity of submitting further requests to this office unless the Repair Procedure undergoes a definite change.

SHOP PROCEDURE FOR REPAIRING IMPERFECTIONS IN NEW MALLEABLE IRON CASTINGS

The purpose of these described procedures is manifold: To facilitate legitimate production by outlining repair practices which are considered satisfactory from a quality viewpoint, and explain them in detail; to provide an incentive for the improvement of casting quality by frank discussion of defects existing and method of repairing them; and to avoid misunderstandings as to quality levels between foundries producing castings, fabricators processing them, and Armed Services procuring them as finished products.

I. Extent

In the case of minor defects, the extent of the defect can be determined by drilling, chipping, grinding, or filing out the defect. While the extent of some major defects can also be determined by drilling, chipping, grinding, or filing out the defect, in many cases the castings would be destroyed. Therefore, nondestructive methods such as x-ray inspection, gamma ray inspection, magnetic particle inspection, black light and fluorescent oil inspection and other accepted methods should

MALLEABLE IRON CASTINGS REPAIR CODE

Type of Repair	*Code Color*
Acetylene Torch, general preheat	Red
Acetylene Torch, local	Red and White hatched
Metallic Arc, general preheat	Silver
Metallic Arc, no	Silver and White hatched
High Temperature Braze (1300° F. +)	Black
Low Temperature Braze (700-1300° F.)	Black and White hatched
Solder	White
Plug, sleeve or bushing	Yellow
Peening	Green
Sealing	Orange
Rusting	Brown

be employed to determine the extent of the defect in the casting.

In the case where mechanical repairs, peening repairs, sealing repairs or rusting repairs are contemplated, non-destructive methods of determining the extent of the defect should be used. If non-destructive methods are not available or suitable, several castings should be broken through the defect, or sectioned through the defect and deep etched to determine the extent and whether it is typical of the general run of castings.

II. Preparation

All defects, with the exception of those which are to be repaired by peening, sealing or rusting, should be properly prepared for repairing. The defect must be removed either by drilling, chipping, grinding, filing, milling, blasting, etc. (When the word "defect" is used, it is understood to mean "the injurious portion thereof.")

When chipping or grinding is used, care should be exercised to be sure that defect is removed. The preferable chipping procedure is to rough chip, then complete preparation by grinding.

Sand or grit blasting may be used for mild cleaning, but cannot be depended upon for dirty, burned-in areas.

Preparation of defects by flame gouging *should not be done.*

In cases where cracks of sufficient size to be considered as major defects are to be repaired, it is good practice to drill small holes beyond each end of the crack. The crack is then ground out from drilled hole to drilled hole. This precaution will prevent cracks from propagating under welding heat.

When doubt exists that the defect is properly removed, an approved method of inspection such as x-ray, gamma ray, magnetic particle inspection, black light, and fluorescent oil inspection, etc., should be used to insure that defect is removed.

III. Method of Repair

A. Arc and Gas Welding: These methods of repair are suitable for both major and minor defects.

1. Preheat

(a) White Iron: Usually the area surrounding the section to be welded should be slowly and uniformly preheated to 1100-1300° F. before welding. Stop-welding temperatures should not drop below 1100° F., and are best checked with a contact thermocouple pyrometer or an optical pyrometer. Temperatures indicating pellets, crayons, paints, or fusible alloy can all be used to check temperatures of castings.

(b) Annealed Iron: Where it is deemed advisable to preheat the annealed casting, procedure as outlined in Paragraph III A 1-a applies. It is not necessary in many cases, however, to preheat for annealed iron welding. The nature of the defect, together with the shape and size of the casting, will determine whether or not preheating is necessary. Usually it is advisable to preheat for the welding of major defects.

2. Welding

(a) White Iron: Welding should start immediately after preheating. Great pains must be taken to keep the heat in the casting high enough to prevent damage to the casting. Following welding, the castings should be immediately put in the heat treating furnace, or allowed to cool slowly and uniformly to room temperature.

(b) Annealed Iron: In the welding of annealed iron even though it may be necessary to preheat the casting, working temperatures of the weld and parent metal adjacent to the weld, should be kept at a minimum consistent with good, sound welds.

With arc welding it is essential that instructions for the use of various types of rods, with respect to amperage, polarity, size, etc., be carefully followed.

Deep puddling is to be avoided. If it is necessary to make a deep weld, it should be done by building up with successive layers of beads, thorough peening following the laying of each bead.

Following welding, the castings should be immediately put in the heat treating furnace or allowed to cool slowly and uniformly to room temperature.

3. Rod or Electrode

(a) White Iron: In the welding of castings in the white iron state—White Iron Rod should be used.

(b) Annealed Iron: For the welding of soft iron or annealed iron castings, rods or electrodes should preferably be of such a nature that the weld has physical and mechanical properties, after final heat treatment, comparable to that of the parent metal. Weld deposit in all cases should be uniformly sound metal and readily machinable after post treatment.

4. Flux

In the case of gas welding, a suitable flux must be used. The flux should provide adequate flotation and fluidity so that the welds are sound and free of slag or gas inclusions.

5. Post Heat

(a) White Iron: Malleablize.

(b) Soft Iron

(1) Gas Welding: All castings that have been repaired by gas welding shall be re-malleablized.

(2) Arc Welding: All castings that have been welded for major defects shall be subjected to a re-malleablizing treatment. Castings that have been welded for minor defects may be given a post treatment consisting of heating the castings to 1275°-1325° F., holding for 8 hours followed by cooling in still air.

B. Special Repair Procedures of Annealed Iron Castings:

1. Welding with Monel Metal Rod or Nickel Rod: This method is suitable for the repair of minor defects and particularly suitable for the repair of defects on machined surfaces and in cases where the castings cannot be given a re-malleablizing treatment.

(a) Preheat: Generally no preheat is required; however, if it is deemed advisable to do so, recommendations are the same as in Paragraph III A 1-a.

(b) Electrode: A rod which will produce a weld deposit of approximately 70 per cent nickel, 30 per cent copper, or a rod that will produce a weld deposit of 94 per cent nickel and 6 per cent manganese should be used. The rod should not exceed 5/32 in. diameter, and may consist of a coated rod of desired composition or a sheathed and coated rod consisting of a nickel core, and copper sheath.

(c) Welding: In general, procedure for annealed iron welding as outlined in Paragraph III A 2-b applies equally to Paragraph III B 1-c. The purpose of this type of welding is to eliminate the necessity of a

re-malleablizing treatment; therefore, it is emphasized that every effort should be made to keep the working temperature of the weld and the parent metal adjacent to the weld at an absolute minimum, which is conducive to good, sound welds. Welding is performed with a standard arc welding machine (A.C. or D.C.).

(d) Post Heat: Castings shall be given a post treatment consisting of heating to from 1275-1325° F., holding for 8 hours, followed by cooling in still air.

2. Nickel Welding (So-called "Cold Welding"): This method of repair is particularly suitable for the repair of minor defects in machined areas, and also in cases where the castings cannot be given a post treatment.

(a) Preheat: None required.

(b) Welding: The welding transformer should provide low voltage (16-12 volts) with high heat (approximately 350 amps.) so that the nickel is melted and is scratched off the wire while in a plastic form. No continuous arc is held, as this would result in a hard, heat affected zone.

This welding operation should be performed by an operator of considerable experience, or one who has demonstrated his ability on samples which are cut and examined for hardness and bond.

(c) Post Heat: None required.

3. Brazing

(a) High Temperature Brazing (Over 1300° F.): This method of repair is suitable for both major and minor defects, and is particularly suitable for repair of castings that cannot be given a re-malleablizing treatment.

(1) Preheat: Same as Paragraph III A 1-a.

(2) Brazing: Following preheating, the rod is held above the cavity and melted with the torch, the molten metal flowing into the cavity.

A suitable flux must be used to flux out the impurities and keep the slag fluid. Care should be taken that the melt is sufficiently hot to permit the impurities to rise from it. However, the temperature should not be maintained any higher than is necessary to accomplish a clean, sound braze.

During brazing a neutral flame should be moved about to maintain uniform temperatures, and to prevent the casting temperature next to the braze from dropping.

When completed, the casting should be immediately placed in the heat treat furnace, or allowed to cool slowly and uniformly to room temperature.

(3) Rod: Tobin Bronze, manganese bronze or equal.

(4) Post Heat: Castings shall be given a post heat treatment consisting of heating to 1275-1325° F., holding for 8 hours, followed by cooling in still air.

(b) Low Temperature Brazing (Under 1300° F.): This method of repair should be confined to minor defects, and is particularly suitable for the repair of castings which cannot be post heated. Since this material melts at a temperature below the critical, and since it is unnecessary to bring the parent metal above this temperature, there is no change in the structure and, therefore, post-heating is not necessary.

Hard silver brazing rod and other similar materials should only be considered for individual cases requiring special treatment. In these cases the procedure should be worked out and approved for the particular casting involved. This class of repair covers a great many widely divergent patented materials with entirely different procedures of application.

Suppliers of these materials should be consulted for proper procedures in case of their use.

These materials flow more freely and fill cavities with greater ease than the metal deposited in arc welding. Moreover, the deposited metal has strength equal to, or greater than, the parent metal, and is readily machinable.

Time is slightly longer than with electric arc, but with experienced operators and properly prepared castings, time can be materially reduced.

(1) Preheat: Same as Paragraph III A 1-a.

(2) Brazing: In general, the technique for low temperature brazing is the same as high temperature brazing, except that the operation is carried out at a much lower temperature.

(3) Post Heat: None required.

4. Soldering: This method of repair should be confined to minor defects. Using the proper type of solder (such as 97.6 per cent Zn, balance Cu, melting point approximately 700° F., or equivalent) and flux, soldering is permissible for the repair of gasket faces or other small machined surfaces showing defects where structural strength or high temperature is not involved.

Strong, uncut hydrochloric acid should be used for soldering flux, and a soldering copper at dull red heat is the preferable method of applying the solder. Preheating the section with a blow torch to approximately 600° F., using 600° F. tempilstik as an indicator, has been found to improve the speed and quality of the job. This solder is harder than ordinary tin-lead solder and melts at a much higher temperature. Such repairs may be finished by filing, machining, or grinding.

5. Mechanical Repairs: Plugs are permissible to repair leaky areas which are subject to compressive stresses or low tensile stresses. Malleable iron plugs should be used and should be taper-threaded (S.A.E. Dryseal American Standard Pipe Threads, pages 605-622, S.A.E. 1944 Handbook) and so used as to have at least three threads engagement as finished. They should be inserted after coating both male and female members with a litharge, glycerine sealer.

6. Peening Repairs: The use of round-nosed, either hemispherical or semi-cylindrical, peening tools and power hammers should be confined to weepers or seepers and should not be attempted for leakers, as defined in Paragraph III B-8. Where leaks exist beyond the weeper or seeper stage, peening repairs should not be attempted.

7. Sealing Repairs: For the repair of leakers beyond the category of weepers or seepers, where the test water under pressure comes through in a fine misty spray and not in a solid stream, polymerizing resin sealers may be used. To make a satisfactory repair, the cavity should be filled with liquid sealer and a pressure of at least 50 psi. applied to force the sealer into the leaks. The sealer should then be drained, and the casting baked at the proper temperature for sufficient time to thoroughly polymerize the sealer.

Only those sealers may be used which, after polymerization, resist

the action of water, alcohol anti-freeze, glycerine anti-freeze, ethylene-glycol anti-freeze, cooling system corrosion inhibitor, gasoline, lubricating oil, trichlorethylene, stoddard solvent, kerosene, or other anti-freeze, corrosion inhibitors, or cooling system cleaners approved by the Procuring Services.

8. Rusting Repairs: The use of sal-ammoniac for rusting up seepers or weepers should be made only by dissolving approximately 10 per cent sal-ammoniac in the pressure leak test water and forcing the sal-ammoniac-water solution into the porous areas under pressure of from 65 to 100 psi. Sal-ammoniac should never be used by being placed on or in castings in high concentration without pressure. Use of sal-ammoniac should not be permitted for leakers beyond the category of seepers or weepers (where liquid comes through under test pressure at rate of not over two drops per second).

A.F.A. Committee Meets In University Foundry

THE University of Michigan's foundry has been the scene of great activity lately due to a very industrious band of men. Who are they? They are members of the A.F.A. Subcommittee on Physical Properties of Iron Molding Materials at Elevated Temperatures, and the university foundry is their meeting place.

The committee, under the chairmanship of Harry W. Dietert, Harry W. Dietert Co., Detroit, has rolled up its sleeves and donned coveralls in an endeavor to work out various assigned foundry problems.

At the June 4-7 meeting of the committee, held at the University of Michigan, a study was conducted along these lines: first, measuring the shake-out effort required to remove cores from castings and second, block penetration test molds were made and the degree of metal penetration was determined.

This group holds four day meetings on a basis of three times a year at the University of Michigan. A technical meeting is held thereafter at which time the data assimulated at the foundry is studied and plans are laid for future projects.

BOOK REVIEW

Calcium Metallurgy Developments

Calcium Metallurgy and Technology, by C. L. Mantell and Charles Hardy. Blue cloth bound, 148 pages, 32 diagrams and illustrations, 27 tables. Published June 21, 1945, by the Reinhold Publishing Corporation, 330 W. 42nd street, New York 18, New York. Price $3.50.

This book is No. 100 of a series of monographs on scientific and technologic subjects, sponsored by the American Chemical Society. The authors, both of whom have been associated with the metallurgical development and applications of calcium for the past twenty years, have done an excellent job of correlating and presenting the known facts about the metal calcium and its alloys.

Chapters one and two of the book discuss the properties and the production of calcium, respectively. The following chapters are devoted to a discussion of calcium alloys of aluminum, copper, gold, lead, magnesium, nickel, silicon, silver, tin, zinc, and other metals; the use of calcium in ferrous metallurgy; calcium hydride; the preparation of chromium, thorium, uranium and zirconium metal powders by the use of calcium; and calcium in the petroleum industry.

Although calcium is produced in relatively small amounts, it has attained considerable metallurgical importance during the past twenty-five years. Many of the processes using calcium have been kept a secret. However, the authors have presented as much information about calcium and its applications as they were permitted to publish.

Former Junior Foundryman Treasurer Visits Office

WILLIAM Wick, specialist (x), second class, stationed at the Naval Research Laboratory, Washington, D. C., was a recent A.F.A. visitor. Bill was the first treasurer, Junior Foundrymen of America, Crane Technical High School, Chicago.

A group picture of the Subcommittee on Physical Properties of Iron Molding Materials at Elevated Temperatures taken at their June meeting in the University of Michigan foundry. The members are: (left to right) Robert Doelman; Bart Sheldon; Ed Olsen; George Watson; Jack Grennan; William Spindler; Chairman Harry Dietert; Harry McMurry; William Seese; Louis Ruffin and Elmer Zirzow.

NEW ASSOCIATION MEMBERS

(June 16 to July 16, 1945)

• Twenty chapter Membership Committees added new names to the ever growing roster of A.F.A. chapters. This month's list is dominated by the newly established Northwestern Pennsylvania chapter which contributed 26 members to rank first; Quad-City chapter, second, increased their roll by 15; and Eastern Canada and Newfoundland chapter, third, added 9.

CENTRAL INDIANA CHAPTER

Charles L. Cowles, Foster Pattern Shop, Columbus.
Wayne C. Gayman, Sand Tester, Golden Foundry Co., Columbus.
P. F. Ulmer, Met., Link Belt Company, Indianapolis.
George B. Yeley, Foreman, Golden Foundry Company, Columbus.

CENTRAL OHIO CHAPTER

James J. Corbett, Foreman, Jeffrey Mfg. Company, Columbus.
George Jenkins, Foreman, Jeffrey Mfg. Company, Columbus.
Paul R. Reynolds, Foreman, Jeffrey Mfg. Company, Columbus.
Thomas W. Rock, Foreman, Jeffrey Mfg. Company, Columbus.
Harry Warsmith, Supt., Jeffrey Mfg. Company, Columbus.

CHESAPEAKE CHAPTER

William Henry Baer, Asst. Met., Naval Research Laboratory, Bellevue, D. C.
John D. Simonson, Serv. Engr., Swan-Finch Oil Corp., New York, N. Y.

CHICAGO CHAPTER

Henry R. Fox, Despatch Oven Co., Minneapolis 14, Minn.
Albert Getty, Special Foreman, American Steel Foundries, East Chicago, Ind.
Ernest A. Hund, Sr., Engr., Lester B. Knight & Associates, Chicago.
James N. Mathias, Partner, Wisnick Accurate Match Plate Co., Chicago.
John J. Sorensen, Indus. Div., Apex Motor Fuel Co., Chicago.
Thomas B. Walton, Foreman, International Harvester Co., Chicago.

CINCINNATI CHAPTER

John C. Dowling, Cleveland Pneumatic Tool Co., Cincinnati.

DETROIT CHAPTER

***Hoskins Mfg. Company, Detroit, Mich. (Leo Lofts, Fdry Supt.).**
Kwok-Wan Yip, Engr., Federal Mogul Corp., Detroit, Mich.
***The Roberts Brass Mfg. Co., Detroit, Mich. (L. C. Smith Jr., Factory Mgr.).**

EASTERN CANADA & NEWFOUNDLAND CHAPTER

Paul Bonin, Asst. Foreman, Jenkins Bros., Ltd., Montreal.
Sol L. Gertsman, Director, Hull Iron & Steel Fdries., Ltd., Hull, Quebec.
H. H. Hutton, Supt., Smiths Falls Malleable Castings Ltd., Smiths Falls, Ont.
***Kingston Silica Mines Ltd., Kingston, Ont. (S. W. Bartlett, Mgr.).**
Albert Lamontague, Pres. & Gen. Mgr., Lamont Alloy Foundry Ltd., Joliette, Que.
A. Gordon McQuat, J. McQuat & Son Ltd., Lachute Mills, Que., (Mgr.).
Morris McQuiggan, Canadian Fdry. Supplies & Equip. Ltd., Montreal, Que.
H. E. Rochon, St. Jerome, P.Q., Canada.
Jean Taillon, Montreal, Quebec, Canada.

METROPOLITAN CHAPTER

R. C. Feagin, Chief Chemist, Austenal Laboratories, Inc., New York, N. Y.
Harold Larsen, Sales Engr., The International Nickel Co., New York, N. Y.
A. W. Smart, Peters-Dalton, Inc., New York, N. Y.
***Steiner-Ives Company, Newark, N. J. (Albert M. Sage, Gen. Mgr.).**

NORTHEASTERN OHIO CHAPTER

Walter J. Amsbary, Met., Lake City Malleable Inc., Ashtabula.
George W. Baillie, Vice-Pres., Quaker City Foundry, Inc., Salem.
Ernst Gustav Billhardt, Annealing Foreman, Lake City Malleable Inc., Ashtabula.
Lawrence E. Emery, Chemist, Lake City Malleable Inc., Ashtabula.
Richard Hastings, Control Supt., Lake City Malleable Inc., Ashtabula.
S. E. Kelly, Asst. Mgr., Eberhard Mfg. Company, Cleveland.
Joseph B. Shoff, Melting Foreman, Lake City Malleable Inc., Ashtabula.

NORTHERN CALIFORNIA CHAPTER

Ventura Pacheco, Molder, Pacific Brass Foundry of S. F., San Francisco.
Chas. E. Romelfanger, Patternmaker, Pacific Brass Foundry of S. F., San Francisco.

NORTHWESTERN PENNSYLVANIA CHAPTER

***American Sterilizer Co., Erie Pa. (Herman L. Zwicker, Gen. Supt.).**
Fred J. S. Carlson, Griswold Mfg. Company, Erie, Pa.
Wm. D. Clark, Clerk, Standard Stoker Co., Inc., Erie, Pa.
Paul H. Coleman, Pattern Shop Foreman, National Erie Corp., Erie.
Floyd H. Comean, Foreman, Erie Malleable Iron Co., Erie.
Fred J. Eisert, Urick Foundry Company, Erie.
***Erie City Iron Works, Erie, Pa. (F. G. Brinig, Pres. & G. M.).**
James J. Farina, Fdry. Supt., American Sterilizer Co., Erie.
Sebastian Fischer, Maint. Foreman, Griswold Mfg. Company, Erie.
Clarence H. Fitz, Fdry. Supt., Hays Mfg. Company, Erie.
Theodore O. Fritz, Cleaning Room Foreman, National Erie Corp., Erie.
Wm. Gathers, Foreman, Erie Malleable Iron Co., Erie.
Henry Gebhardt, Foreman Pattern Dept., Hays Mfg. Company, Erie.
***General Electric Company, Erie, Pa. (L. A. Dunn, Supt. of Fdries.).**
Francis Guthrie, Fdry. Foreman, Erie Malleable Iron Co., Erie.
***Hays Mfg. Co., Erie, (Wm. H. Forster, Jr., Pres.).**
Barker L. Hitchcock, Main. Foreman, Erie Malleable Iron Co., Erie.
J. Douglas James, Foundry Met., Erie City Iron Works, Erie.
***Mutual Foundry Co., Franklin (J. B. Williams, Pres.-Mgr.).**
***National Erie Corporation, Erie (W. I. Johnson, Pres.).**
Ralph J. Oboth, Urick Foundry Co., Erie.
Joseph A. Shuffstall, Asst. Plant Mgr., National Erie Corp., Erie.
Arthur F. Sitter, Core Room Foreman, Hays Mfg. Company, Erie.
E. A. Steinfurth, Insp. Naval Material, U. S. Navy Dept., Erie.
Rocco Taccone, Foundry Foreman, Hays Mfg. Company, Erie.
E. H. Watts, Engr., Erie Malleable Iron Company, Erie.

ONTARIO CHAPTER

W. P. Garden, Dominion Oxygen Company, Ltd., Toronto, Ont.
Stanislav Kvarda, Foreman, Bata Shoe Co. of Canada, Ltd., Batawa, Ont.
***Ritchey Supply Company Ltd., Toronto, Ont. (Robert M. Addison, Vice-Pres. & Mgr.).**

PHILADELPHIA CHAPTER

William J. Gallana, Vice-Pres., Rogers Brown Lavino Company, Philadelphia.
John F. McKinney, Fdry. Foreman, Sun Shipbuilding & Drydock Co., Chester.

QUAD-CITY CHAPTER

William C. Bell, Prod. Engr., Frank Foundries Corp., Moline, Ill.
James W. Cale, Core Room Supt., Ordnance Steel Fdry. Co., Bettendorf, Iowa.
Don Canfield, Salesman, Federal Foundry Supply Co., Cleveland, Ohio.
Elmer George, Core Room Foreman, Ordnance Steel Fdry. Corp., Davenport, Iowa.
Al Goulet, Fdry. Foreman, International Harvester Co., Rock Island, Ill.
Raymond C. Howell, Plant Engr., Ordnance Steel Fdry. Co., Bettendorf, Iowa.
W. L. James, Molding Foreman, John Deere Spreader Works, E. Moline, Ill.
John A. Jones, Ordnance Steel Foundry Co., Bettendorf, Iowa.
Ted. A. Kraklow, Gen. Foreman, John Deere Spreader Works, E. Moline, Ill.
Harold F. Malmstrom, Foreman, J. I. Case Co., Rock Island, Ill.
Stanley Olson, Gen. Foreman, J. I. Case Co., Rock Island, Ill.
O. J. Popelier, Foreman, John Deere Spreader Works, E. Moline, Ill.
Leonard Ross, Foreman, J. I. Case Co., Rock Island, Ill.
Louis Paul Smith, Vice-Pres. of Mfg., French & Hecht, Inc., Davenport, Iowa.
Nolan Harold Williams, Asst. Plant Engr., Ordnance Steel Fdry Co. Bettendorf.

SOUTHERN CALIFORNIA CHAPTER

Harry H. Beyma, Kaiser Company, Los Angeles.
***Los Angeles Brass Company, Los Angeles (Don C. Davidson).**
***R. H. Osbrink Mfg. Company, Los Angeles (A. R. Goodman, Gen. Mgr.).**

TEXAS CHAPTER

W. J. Buschman, Coremaker, Lufkin Fdry. & Machine Co., Lufkin.
Geo. H. Mayer, National Carbon Co., Inc., Dallas.
Arthur S. Peter, Foreman, Texas Foundries, Inc., Lufkin.
Frederick Windisch, Foreman, Hartwell Iron Works, Houston.

TWIN-CITY CHAPTER

***Alm Pattern Company, Minneapolis, Minn. (George Alm, Partner).**
Richard Lasota, Purchasing Agent, Hart Carter Co., Minneapolis, Minn.
L. William Williamson, Mpls. Moline Power Implement Co., Hopkins, Minn.

WESTERN MICHIGAN CHAPTER

John M. Manson, Foundry Trainee, Campbell, Wyant & Cannon Fdry. Co., Muskegon.

WESTERN NEW YORK CHAPTER

Norbert B. Grace, Time Study Eng., Symington-Gould Corp., Depew.
M. T. MacPherson, Fdry. Engr., Symington-Gould Corp., Depew.

WISCONSIN CHAPTER

Hilbert E. Keller, Supt., Production Pattern Company, Milwaukee.

*Company Member.

OUTSIDE OF CHAPTER

Lt. Herbert E. Cragin, Jr., Foundry Officer, U. S. Navy, San Francisco, Calif.
Paul C. Fassotte, Consultant, Leeds, England.
R. L. Jacobs, Vermont Foundries Inc., Springfield, Vermont.
Joe Krupsky, Vermont Foundries Inc., Springfield, Vermont.
Benjamin MacDougall, Asst. Fdry. Mgr., Rolls Royce, Ltd., Glasgow, Scotland.
Edward Byron McPherson Jr., ML 1/c, U. S. Navy, San Franciso, Calif.
N. P. Newman, Managing Dir., Newman, Hender & Co., Ltd., Gloucester, England.
Power Jets Research & Development, Whetstone, Leicester, England.
Charles G. Seifert, Jr., Tech. Dir., La Consolidada, S. A., Mexico, D. F.

*Company Member.

Foundry Personalities

James H. Smith, A.F.A. National Director and General Manager, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich., has been appointed to the staff of W. C. Williams, Jr., Vice-President and group executive in charge of accessory divisions, General Motors Corp., Detroit.

E. K. Smith, well known to A.F.A. members for his gray and malleable iron talks at chapter meetings and for his committee work in the same fields, recently returned to this country from China. He was a Specialist in Metallurgy, Far Eastern Branch, Division of Cultural Co-operation, U. S. Department of State and his work carried him into numerous Chinese foundries.

E. K. Smith

Charles P. Whitehead has been elected President, General Steel Castings Corp.

Allan S. Noyes, formerly with Hydro-Blast Corp., Chicago, has been appointed Divisional Technical Manager, Foundry Rubber Compounds Corp., Washington, D. C., with offices in Chicago.

Dan A. Farrell, foundry superintendent, Carnegie-Illinois Steel Corp., Chicago, has been appointed supervisor of safety with headquarters in Pittsburgh. Active in Chicago A.F.A. chapter as Entertainment Committee Chairman.

William R. Manske has been made Works Manager, Denver plant, Amsco Div., American Brake Shoe Co. He is an A.F.A. member and was in the St. Louis District chapter.

William R. Manske

Professor Thomas Turner, Netheridge, Elm Drive, Leatherhead, England, in a letter recently received by Secretary R. E. Kennedy, extends his greetings to all his friends in America.

Prof. Turner is the oldest medalist and honorary life member of the Association.

G. A. Custer has been promoted from chief engineer to general factory manager, Peninsular Grinding Wheel Co., Detroit. He came to Peninsular as a chief engineer 9 years ago.

L. W. Barger has been named General Works Engineer for the Symington-Gould Corp., Depew, N. Y. Previous to his advancement Mr. Barger was Works Engineer, and has been succeeded by **W. C. Weaver.**

Obituaries

Charles E. Brinker, Whitehead Metal Products Co., New York, who has been an A.F.A. member for 15 years, died June 30.

Henry P. Mueller, Sr., Mueller Brass Foundry Co., St. Louis, died June 24.

Louis Stockstrom, chairman of the board, American Stove Co., St. Louis, died recently, at the age of 86. With his brother, the late Charles Stockstrom, he founded the Quick Metal Stove Co. in 1812, which later became the American Stove Co.

New Literature

The Battelle Memorial Institute, Columbus, has published a booklet on books, publications and patents of Battelle during 1929-1944. Over eight hundred items are listed in this booklet.

Friction materials for industrial machinery manufactured by Raybestos-Manhattan, Inc., Passaic, N. J., are described in the manufacturers' catalog.

A folder covering Klem Kleaners, produced by Klem Chemical Works, Detroit, concerning derusting, soldering and maintenance processes is now available for distribution by writing to this firm.

United States Department of Labor, Washington, D. C., has printed bulletin No. 805 in relation to "Injuries and Accident Causes in the Foundry Industry, 1942." There is a slight charge for this publication.

American Air Filter Co., Inc., Louisville, Ky., in bulletin No. 251 gives complete details on their new electronic unit designed to collect oil mist from high-speed cutting tools.

A bulletin on duplex malleable iron is now available for general distribution from The Jackson Iron & Steel Co., Jackson, Ohio.

"Methods of Testing and Protecting Eyesight in Industry," Industrial Health Series Booklet No. 4, has been distributed by Metropolitan Life Insurance Co., New York. Many principles of industrial lighting are revieved.

(Concluded on Page 100)

CHAPTER OFFICERS

R. S. Davis
National Malleable and Steel Castings Co., Indianapolis
Chairman
Central Indiana Chapter

T. E. Barlow
Battelle Memorial Institute, Columbus
Chairman
Central Ohio Chapter

A. W. Schneble
Advance Foundry Co., Dayton
Chairman
Cincinnati Chapter

H. A. Deane
American Brake Shoe Co., New York
Chairman
Metropolitan Chapter

G. Ewing Tait
Dominion Engineering Works, Lachine, P.Q.
Chairman
Eastern Canada and Newfoundland Chapter

T. D. Barnes
Don Barnes Foundry Supplies and Equipment, Hamilton, Ont.
Chairman
Ontario Chapter

R. R. Haley
Advance Aluminum and Brass Co., Los Angeles
Chairman
Southern California Chapter

C. E. VonLuhrte
Chicago Retort and Fire Brick Co., Davenport
Chairman
Quad City Chapter

H. F. Taylor
Naval Research Lab., Washington, D. C.
Chairman
Chesapeake Chapter

J. C. Gore
Werner C. Smith Co., Chicago
Chairman
Chicago Chapter

E. G. White
Crouse-Hinds Co., Syracuse
Chairman
Central New York Chapter

E. C. Hoenicke
Eaton Mfg. Co. Detroit
Chairman
Detroit Chapter

SOUTHERN CALIFORNIA CHAPTER
Analyzes Apprentice Training Work

By James B. Morey, International Nickel Co.,
Los Angeles

IN a tribute to the wartime accomplishments of the country's foundry industry, Leslie Ball, assistant technical director, Triplett & Barton, Inc., Burbank, Calif., pointed out in a recent talk before the Southern California chapter that only by scientific methods of "quality control" can the industry hope to retain its present high position in metals fabrication. The meeting was held June 22 at the Elks Club, Los Angeles.

This was the last regular meeting of the 1944-45 season at which the newly elected officers and directors were installed and a program of entertainment presented as an added feature. Albert G. Zima, International Nickel Co., and Chapter Past-President, presented the President's ring to W. D. Bailey, Jr., Westlectric Castings, Inc., E. Los Angeles, the retiring President.

James G. Russell, War Manpower Commission, topped off a full evening with a worth-while analysis of "Apprentice Training." In view of the foundry industry's difficulties in securing new, skilled help, in common with most other businesses today, the importance of organized and intelligent training of apprentices was especially stressed by Mr. Russell. It is noted that here in Southern California considerable interest is being shown this season, as in past years, in the employing and training of high-school boys not yet subject to military service.

Present at this meeting was E. K. Smith, prominent metallurgist, who just returned from China. He gave a short illuminating talk on Chinese foundries and foundry practice.

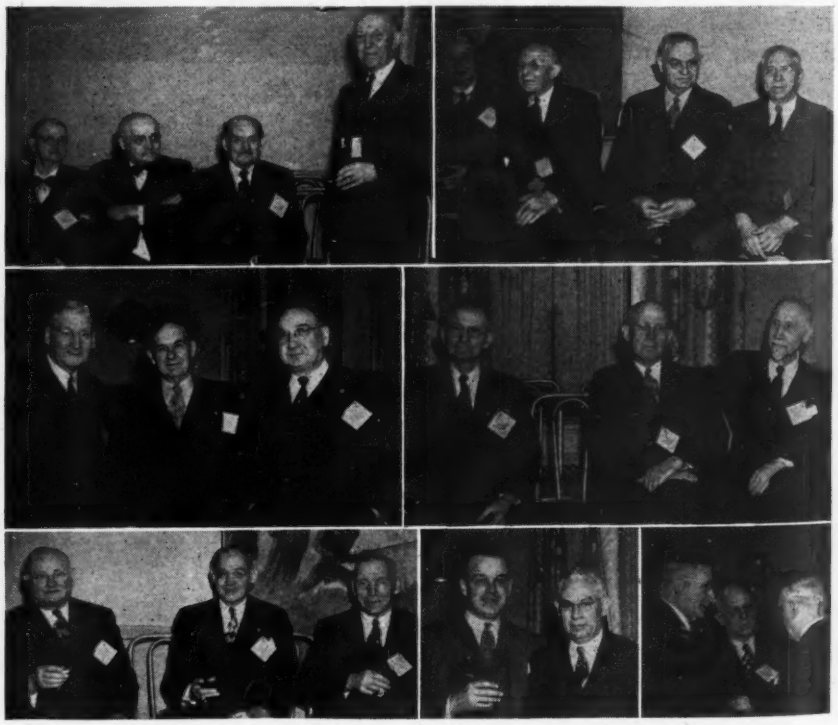
Texas Chapter Outing Rounds Up Good Golfers

By Leroy G. Stenzel,
Stenzel Pattern Works, Houston

TEXAS chapter members held their annual golf tournament June 14 at the Golfcrest Country Club, Houston. Robert H. Lang, Lufkin Foundry & Machine Co., Lufkin, showed the foundrymen a few pointers about the ancient Scottish game as he copped tournament honors.

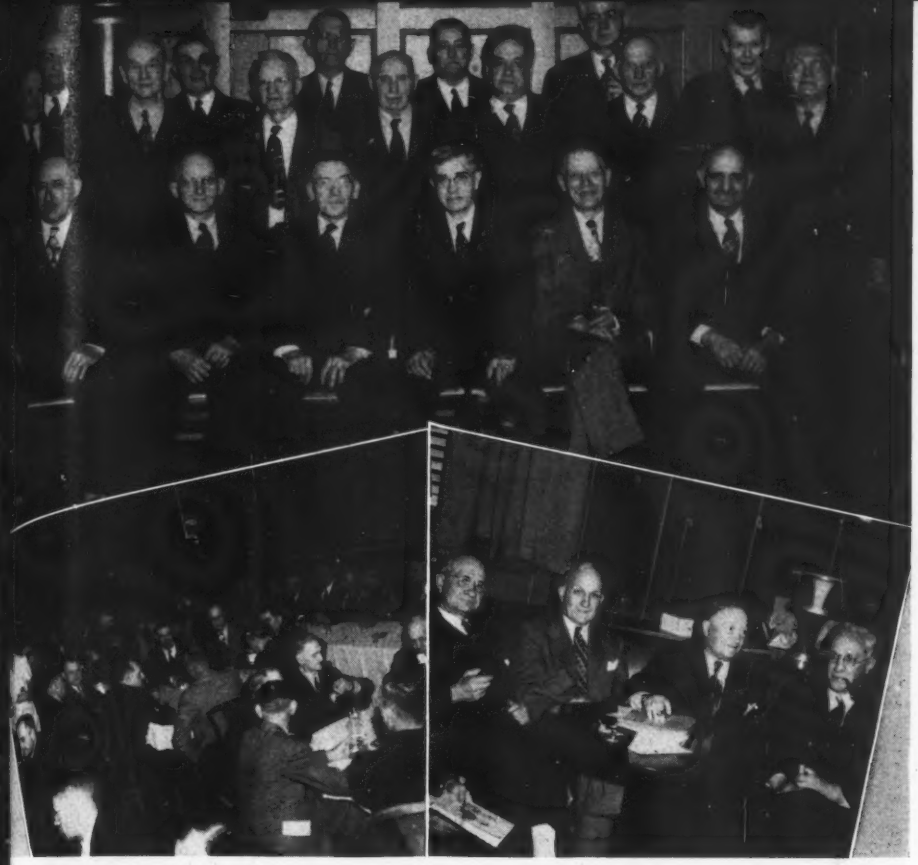
Following the dinner the members were notified of the election results and these men assume office: *Chairman,* E. P. Trout, Lufkin Foundry & Machine Co., Lufkin; *Vice-Chairman,* Wm. M. Ferguson, Texas Electric Steel Casting Co., Houston; *Secretary-Treasurer,* W. L. Wren, R. Lavin & Sons, Inc., Houston; and *Directors,* J. O. Klein, Texas Foundries, Inc., Lufkin; Owen Murphy, Star Foundry Co., Houston; Arthur H. Stenzel, Stenzel Pattern Works, Houston, and W. C. Fleming, Hughes Tool Co., Houston.

Speaker at the technical meeting was R. H. Ruell, Chicago, who gave an enlightening talk on wage incen-



(Photos courtesy John Bing, A. P. Green Fire Brick Co.)

A few of the "Old Timers" who enjoyed the Wisconsin chapter's Annual Old Timers Night to its fullest.



Old Timers' Night at the Northern Illinois-Southern Wisconsin chapter brought forth an unusual number of honored guests at the first meeting of this type held by this chapter. The nineteen guests shown above are: (first row sitting, left to right)—C. C. Kawin, Chas. C. Kawin Co., Chicago; Chas. Palmer, Fairbanks, Morse & Co., Beloit; Dan Hallifey, Beloit Iron Works, Beloit; Hagbert Sorenson, Beloit Iron Works, Beloit; Carl Anderson, Mattison Machine Works, Rockford; Pasquale Calacurcio, Mattison Machine Works, Rockford; (second row standing, left to right)—F. E. Rutz, Gunite Foundries Corp., Rockford; Conrad Althaus, National Sewing Machine Co., Belvidere; Jack Lonergan, Geo. D. Roper Corp., Rockford; John Burstrom, Greenlee Bros. & Co., Rockford; George Crone, Geo. D. Roper Corp., Rockford; John Spearing, J. I. Case Co., Rockford; Walfred Palm, Mattison Machine Works, Rockford; (third row standing, left to right)—August Christian, Arcade Mfg. Co., Freeport; Pat McEntee, Geo. D. Roper Corp., Rockford; August Leubke, Greenlee Bros. & Co., Rockford; Levi Hallen, W. L. Davey Pump Co., Rockford; Henery Horne, Beloit Iron Works, Beloit; and Andy Weigert, Geo. D. Roper Corp., Rockford.

tives and time studies. The speaker explained how confidence must be established by accurate basing and a full, clear explanation of the advantages offered by the particular wage incentive plan selected.

Cincinnati Stag Party Draws Capacity Crowd

By J. Schumacher,
Hill & Griffith Co., Cincinnati

GOLFERS, and duffers, had a field day at the annual outing held by the Cincinnati chapter at the Summit Hills Country Club, Fort Mitchell, Ky., June 13. A crowd of 255 men had a perfect day to play golf, baseball, horseshoes, darts and other sports.

A big dinner followed the day's activity and the new officers and directors of the chapter were introduced. These men will guide the chapter during the coming year: *Chairman,* A. W. Schneble, The Advance Foundry Co., Dayton; *Vice-Chairman,* J. Schumacher, Hill & Griffith Co., Cincinnati; *Secretary,* W. H. Hoppenjans, Jr., Star Foundry Co., Covington, Ky.; *Treasurer,* W. J. Love, Jr., Lunkenheimer Co., Cincinnati; and *Directors,* Emil Albrecht, Aluminum Foundry Co., Cincinnati; E. Kihn, Cincinnati Milling Mach. Co., Cincinnati; and C. D. Steinmeier, A. D. Cook, Inc., Lawrenceburg, Ind.

Central Ohio Names Tom Barlow Chairman

THE all-important task of keeping the Central Ohio chapter active has been placed in the hands of the newly elected officers and directors of that chapter. Their positions are as follows: *Chairman,* Tom E. Barlow, Battelle Memorial Institute, Columbus; *Co-Chairman,* Norman J. Dunbeck, Eastern Clay Products, Inc., Eifort; *Secretary,* Karol W. Whitlatch, Aetna Fire Brick Co., Oak Hill; *Treasurer,* R. H. Frank, Bonney-Floyd Co., Columbus; and *Directors,* Frank Kiper, Ohio Steel Foundry Co., Springfield; Fred W. Fuller, National Engineering Co., Columbus; Karl Presser, National Supply Co., Springfield; H. Kenneth McGrath, Alten's Foundry & Machine Works, Lancaster; John F. Lacey, Commercial Steel Castings Co., Marion; and William R. Huffman, H. B. Salter Mfg. Co., Marysville.

Cement Pattern Work Covered by Schleede

By J. Schumacher,
Hill & Griffith Co., Cincinnati

EXPLAINING through the medium of a sound slide picture, which described in detail the applications of gypsum cement and the methods of making patterns from it, E. H. Schleede, development engineer, U. S. Gypsum Co., Chicago, Ill., covered a most interesting subject at the May 14 meeting of the Cincinnati chapter. "Patterns of Gypsum Cement and Metal Casting in Plaster" was the title of Mr. Schleede's paper. After the picture was shown he discussed many factors concerning the use of plaster patterns and how often the wrong types of plaster are chosen for the application.

NEFA Considers Many Problems of Foundrymen

By Merton Hosmer,
New England Foundrymen's Assn., Boston

AROUND table discussion of many topics featured the April 11 meeting of the New England Foundrymen's Association held at the Engineers' Club, Boston, Mass.

An explanation of the advantages of the sand slinger occupied a large part of the evening.

A. E. Blake, Jr., General Electric Co., spoke briefly on costs and depreciation of foundry equipment, and E. H. Ballard, of the same com-

pany, added details to the remarks.

Joe Stazinski, General Electric Co., added his statements concerning the advantages of the sand slinger in connection with the use of wooden patterns.

Tom Weiser, Griffin Wheel Co., commented upon the use of respirators in regards to shake-outs.

Jim Gillis, Roxbury Steel Casting Co., spoke at length on the advantages of knock-off risers and number, size and feeding orifices necessary.

NEFA Meets With OPA And Hears Taylor Talk

By Merton Hosmer, New England Foundrymen's Assn., Boston

PRESENTATION of important data concerning gating and risering was given at the May 9 meeting of the New England Foundrymen's Association held at the Engineer's Club, Boston.

Dispensing the information was guest speaker, H. F. Taylor, Naval Research Laboratory, Anacostia Station, Washington, D. C. Mr. Taylor, who has just been named Chairman, A.F.A. Subcommittee on Physical Properties of Steel Foundry Sands at Elevated Temperatures, spoke on "Gating and Risering of Ferrous and Non-Ferrous Metals."

Preceding the meeting an OPA Clinic was held at the OPA Regional Offices. A discussion on "Maximum Price Regulation No. 244 Covering the Sale and Purchase of Gray Iron Castings" was conducted by Weldon Welfling, Chief, Castings Section, OPA, Washington.

At the June meeting of the Northern California chapter the members paid tribute to the chapter's Apprentice Training Committee and a number of apprentices. Top—Chapter members who stayed until the meeting closed and had their picture taken. Bottom—Four apprentice committeemen pictured with apprentices. The men are identified as: (sitting, left to right)—Harry McBride; Aaron Loomis; Jos. Souza; David Madeiros; J. L. Melling, committeeman; Carl Silva, Robert Silva, (standing, left to right)—Eugene Perry; John Joseph; V. B. Lawrence, committeeman; Wm. J. Logue, committeeman; Loren Stevens, committeeman; E. A. Carroll, and Roy Shepardson.

Western New York Holds Annual Meeting-Party

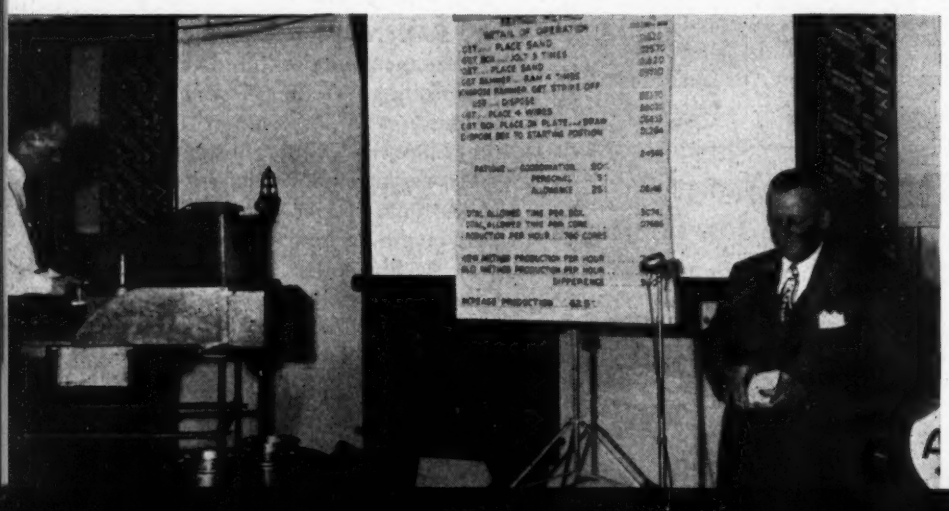
By J. Ralph Turner, Queen City Sand & Supply Co., Buffalo

THE annual meeting of the Western New York chapter was held June 16 at the Hotel Buffalo, Buffalo. A review of the chapter's activity was made following which the newly elected officers and directors of the chapter were introduced to the membership. The pin awarded each year to the retiring chairman was presented to R. D. Loesch, Lake Erie Foundry Co., Buffalo, by Past Chairman Frank E. Bates, Worthington Pump & Machinery Corp., Buffalo.

After the regular meeting the members and guests were entertained with an excellent floor show.

Stuart D. Martin (left) and James H. Smith, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich., put on their actual time and motion study demonstration for the Saginaw Valley foundrymen.

(Photos courtesy George R. Wlodyga)



Officers and Directors Named for West. Michigan

OFFICERS and directors for the Western Michigan chapter were elected by members of that chapter at its May meeting. Those to serve are: *Chairman,* J. Wesley Lee, The Challenge Machinery Co., Grand Haven; *Vice-Chairman,* Fred C. McCarthy, Wolverine Brass Works, Grand Rapids; *Secretary,* Rudolph Flora, Clover Foundry Co.,

(Photos courtesy John Bing, A. P. Green Fire Brick Co.)
Pictures taken at the Wisconsin chapter's Annual Old Timers and Apprentices Night.

Muskegon; *Treasurer,* Arthur Green, Dake Engine Co., Grand Haven; and *Directors,* Chas. H. Cousineau, West Michigan Steel Foundry Co., Muskegon; W. R. Krepps, Campbell, Wyant & Cannon Foundry Co., Muskegon; A. G. Raddatz, Lakeshore Machinery & Supply Co., Muskegon; and Joseph L. Brooks, Muskegon Piston Ring Co., Sparta.

Kohler Brings Plaster Data to New England Men

By Merton A. Hosmer, President, New England Foundrymen's Assn., Boston

MEETING at the Engineer's Club, Boston, June 13, members and guests of the New England Foundrymen's Association heard M. E. Kohler, Scientific Cast Products Corp., Cleveland, speak on "Pattern Equipment Cast in Plaster." The speaker presented many slides portraying the possibilities of multiple patterns.

Pindell Guides Oregon During Coming Season

THE election of officers and directors for the Oregon chapter are as follows: *Chairman,* W. R. Pindell, Northwest Stove & Furnace Works, Inc., Portland; *Vice-Chairman,* Nate Weinger, Peninsula Foundry Co., Portland; *Secretary-Treasurer,* A. R. Prier, Oregon Brass Works, Portland; and *Directors,* A. J. Grbavac, Columbia Steel Casting Co., Portland; A. B. Holmes, Crawford & Doherty Co., Portland; H. L. Tatham, Pacific Steel Foundry, Portland; Frank A. Miller,

Chapter Meetings August 15 - September 15

August 18

Chicago

ANNUAL STAG OUTING
Lincolnshire Country Club
Chicago Heights, Ill.

✦

Canton District

ANNUAL STAG OUTING
Estate of Otis Clay,
Canal Fulton, Ohio

✦ ✦

August 25

Ontario

ANNUAL PICNIC
"Barnesdale," Estate of R. Barnes,
Waterdown, Ontario

September 8

Birmingham District

ANNUAL OUTING
Roebuck Country Club

✦ ✦

September 10

Cincinnati

Engineering Society Headquarters,
Cincinnati
B. P. MULCAHY
Citizens Gas & Coke Utility
"Foundry Coke"

✦ ✦

September 13

St. Louis District

DeSoto Hotel, St. Louis
"Core Blowing"
Plant Visitation

✦

Northeastern Ohio

Cleveland Club
L. B. KNIGHT
L. B. Knight & Associates
NATIONAL OFFICERS NIGHT

September 14

Central Ohio

ANNUAL OUTING
Brookside Country Club,
Columbus, Ohio

✦ ✦

September 15

Western New York

ANNUAL PICNIC
Sturms Grove, Buffalo, N. Y.

✦ ✦

September 28

Chesapeake

Engineers Club, Baltimore, Md.

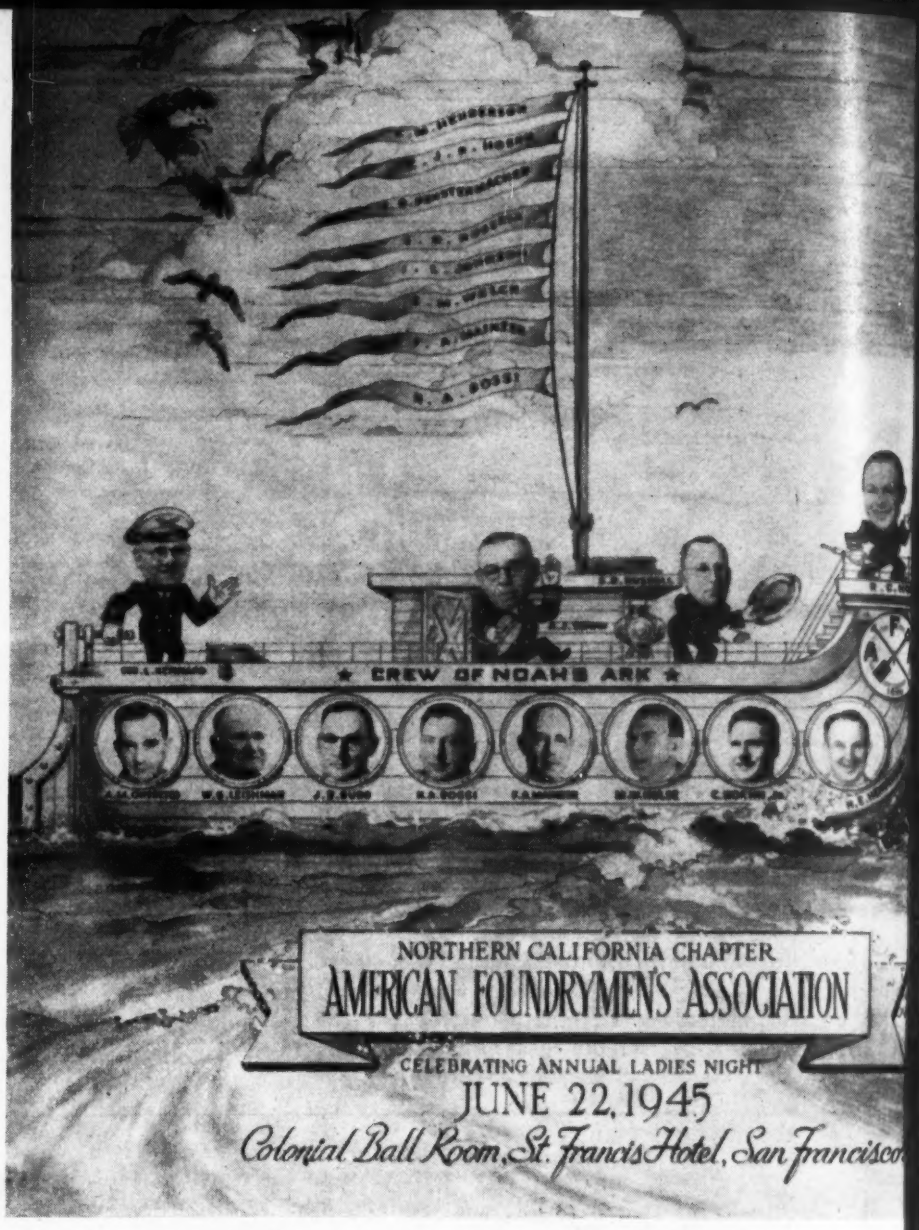
Western Industrial Supply Co., Portland; S. E. Peeler, Electric Steel Foundry, Portland; and F. A. Stephenson, Dependable Pattern Works, Portland.

Wisconsin Chapter Elects Its Officers for New Year

AT a recent meeting of the Wisconsin chapter the election of officers and directors was held. Those named to serve the chapter are as follows: *President,* John Bing, A. P. Green Fire Brick Co., Milwaukee; *Vice-President,* David Zuege, Sivyer Steel Casting Co., Milwaukee; *Secretary,* Russell Anderson, Belle City Malleable Iron Co., Racine; *Treasurer,* R. F. Jordan, Sterling Wheelborrow Co., Milwaukee; and *Directors,* Robert C. Woodward, Bucyrus Erie Co., Milwaukee; William Eck, Wisconsin Aluminum Foundry Co., Inc., Manitowoc; M. A. Dantzler, Rundle Mfg. Co., Milwaukee; and J. J. Ewens, Grede Foundries, Inc., Milwaukee.

Correction!

E. T. Kindt, Kindt-Collins Co., Cleveland, in a recent issue of AMERICAN FOUNDRYMAN was quoted as saying "there is only one patternmaker per 100,000 population in the U. S." This statement should have read "about one patternmaker to every 10,000 population."


CREW OF NOAH'S ARK
NORTHERN CALIFORNIA CHAPTER
AMERICAN FOUNDRYMEN'S ASSOCIATION
CELEBRATING ANNUAL LADIES NIGHT
JUNE 22, 1945
Colonial Ball Room, St. Francis Hotel, San Francisco

Program cover designed by the Northern California chapter for their Annual Ladies Night Party shows artistic ability and ingenuity.

Bowling is as popular in California as it is in Brooklyn, and here are two of the eighteen teams that took part in the Southern California chapter's bowling league to prove it. Two leagues had to be formed in order to accommodate all the squads that participated. Bowlers had to be A.F.A. members or work for a company member. Bob Haley, Advance Aluminum & Brass Co., Los Angeles, and president, Southern California chapter, organized the first league three years ago and it has been growing stronger each year.

Hoehn Heads Officers Of Northern California

THE Northern California chapter has placed its slate of officers and directors before the members for final decision. The following were elected: *President,* Charles Hoehn, Jr., Enterprise Engine & Foundry Co., San Francisco; *Vice-President,* Richard Vosbrink, Berkeley Pattern Works, Berkeley; *Secretary-Treasurer,* Geo. L. Kennard, San Francisco; and *Directors,* H. E. Henderson, H. C. Macaulay Foundry Co., Berkeley; H. E. Eggerts, Berkeley Brass Foundry Co., Berkeley; G. W. Penning, Enterprise Engine & Foundry Co., Richmond plant; and Ralph C. Noah, San Francisco Iron Foundry.

Abstracts

NOTE: The following references to articles dealing with the many phases of the foundry industry, have been prepared by the staff of *American Foundryman*, from current technical and trade publications.

When copies of the complete articles are desired, photostat copies may be obtained from the Engineering Societies Library, 29 W. 39th St., New York, N. Y.

Aluminum-Base Alloys

BORON. *"Effect of Boron on Aluminum Castings,"* THE IRON AGE, June 21, 1945, vol. 155, no. 25, p. 61.

The results of a test to determine the effect of boron trichloride on the physical properties of a 356 permanent mold casting alloy.

GENERAL PURPOSE ALLOY. Quadt, R. A., *"Properties of a General Purpose Aluminum Sand Casting Alloy,"* ALUMINUM AND MAGNESIUM, June, 1945, vol. 1, no. 9, pp. 18-19, 22-23.

Of particular interest to foundrymen are alloys which have the ability to produce a wide range of mechanical properties, good machinability, good corrosion resistance, and good casting properties such as low shrinkage, good fluidity, freedom from hot shortness, pressure tightness, and ease of feeding. No one alloy fulfills all of these requirements. However, some general purpose alloys do have certain combinations of these properties which are considered a good compromise.

The author discusses a general purpose alloy of the aluminum-copper-silicon group, which has the best combination of properties when it contains from 3.5 to 4.0 per cent copper and from 3.0 to 3.5 per cent silicon. The author discusses the effect of pouring temperatures on the physical properties and the effect of room temperature aging on this alloy.

PERMANENT MOLDS. *(See Permanent Molds.)*

Chemical Analysis

SPOT TESTS. Hammond, W. H., *"A Spot Test for Molybdenum in Steel,"* THE IRON AGE, June 28, 1945, vol. 155, no. 26, pp. 75-76, 138-139.

A description of a spot test for determining molybdenum content in alloy steels, based on the red molybdenum cinchonine-thiocyanate complex precipitate of Johnson. This test is for use as a screening agent and should not be considered a substitute for quantitative chemical analysis.

Gray Cast Iron

HARDNESS TEST SPECIMENS. *(See Hardness Testing.)*

Hardness Testing

GRAY IRON. Crow, Thomas B., *"A Convenient Form of Cast-On Indentation Hardness Test-Piece."* FOUNDRY TRADE JOURNAL, May 31, 1945, vol. 76, no. 1502, pp. 96-97.

The author has found that a test-piece of triangular cross section, cast on a gray iron casting at any desired position, makes an excellent specimen for use in determining hardness by indentation methods. Although the hardness of the specimen may not be exactly that of the casting, the readings obtained are still useful for comparison purposes.

The author decribes the method by which he prepares his specimens and lists some of the advantages of their use.

Heat Treatment

THERMAL LAG. Peace, A. E., *"Thermal Lag in Heat-Treatment Operations, with Particular Reference to the Annealing of Malleable Cast Iron,"* FOUNDRY TRADE JOURNAL, May 24, 1945, vol. 76, no. 1501, pp. 67-72.

After a discussion of the elementary principles of heat transfer, the author describes thermal lag and gives practical examples of its effects. He also discusses the effects of shape and size of annealing pots and types of heat-treatment furnaces on thermal lag.

Included in the article are tables giving the thermal conductivity of some metals, non-metallic solids and gases; specific heat of some metals and non-metallic solids over a range of 0-100 deg. C.; and the relation of surface area to volume of malleable annealing pots.

Light Metal Alloys

PATTERN EQUIPMENT. *(See Pattern Equipment.)*

Magnesium-Base Alloys

FIRE HAZARDS. *(See Safety and Hygiene.)*

GERMINATION. Peters, A. T., Busk, R. S., and Elliott, H. E., *"Factors Affecting Abnormal Grain Growth in Magnesium-alloy Castings,"* A.I.M.E. Technical Publication No. 1864, METALS AND ALLOYS, June, 1945, vol. 12, no. 4, 23 pp.

Under certain casting conditions, some magnesium-base alloys exhibit local grain growth on heat treating without having undergone previous mechanical stressing. This occurs only in alloys of certain compositions which have been treated in such a manner as to produce a very fine as-cast grain size. It is believed that the mechanism of this grain growth is a general recrystallization of the as-cast structure, followed by a coalescence of a few grains and subsequent growth of these grains.

Special heat treating cycles have been developed to inhibit germination. Chill coatings and careful gating have also proven helpful.

GRAIN REFINEMENT. Hultgren, Ralph, Mitchell, David W., and York, Bernard, *"Grain Refinement of a Carbothermic Magnesium Alloy by Superheating,"* A.I.M.E. Technical Publication No. 1853, METALS AND ALLOYS, June, 1945, vol. 12, no. 4, 8 pp.

A series of tests on an A.S.T.M. No. 17 magnesium-base alloy of carbothermic origin revealed facts about grain refinement which are contrary to those generally believed to be true of alloys of electrolytic origin. Single heats of metal which were divided into portions which received different superheating treatments were cast into heated cast-iron molds, cold baked sand molds, and heated baked sand molds. After the casting had solidified, the sprue was removed, the casting was sectioned, the sections were heat treated and then prepared for study of the grain size.

A study of the specimens thus prepared indicated that full grain refinement could be obtained at temperatures as low as 1400° F. This is lower than the temperatures considered necessary for grain refinement of alloys prepared from electrolytic magnesium. Unsuperheated alloys held at 1300° to 1350° F. showed incomplete grain refinement, while superheated alloys held at those temperatures showed a slight degree of coarsening. The experiments showed that grain size is virtually independent of superheat temperature if sufficient time for superheating is allowed. The No. 17 alloy required one hour at 1400° F. and less time at higher temperatures.

Although the nucleating agent is not known, it is believed possible that carbides in carbothermic magnesium might be responsible for the grain refinement taking place at low temperatures.

Two tables included with the article give data showing the grain size as a function of superheat temperature and the effect on grain size of time of holding unsuperheated metal at 1400° F.

GRAIN REFINEMENT. Hultgren, Ralph, and Mitchell, David W., *"Grain Refinement of Magnesium Alloys without Superheating,"* A.I.M.E. Technical Publication No. 1954, METALS AND ALLOYS, June, 1945, vol. 12, no. 4, 5 pp.

Grain refinement of magnesium-base alloys may be brought about by several means, including bubbling of gas, addition of solid agents, mechanical agitation, and superheating. The authors compare the degree of grain refinement obtained by these means and discuss in particular the refinement of grains by means of stirring.

The authors found that they could bring about grain refinement without superheating by stirring the metal vigorously at 1400° F. This was true of both carbothermic and electrolytic metal. The greatest amount of grain refinement was brought about in the first minute of stirring. It was found to be permissible

to let the metal stand at 1400° F. after stirring, to prevent flux and oxide inclusions. Increasing the temperature at which stirring was performed had no effect on the degree of grain refinement, nor did the type of crucible used.

Tables presented with the article give the compositions of the alloys used, a comparison of the grain size obtained in an A.S.T.M. No. 17 alloy after treating it for 5 minutes at 1400° F. and superheating for 15 minutes at 1600° F., and the effect of stirring time on both carbothermic and electrolytic No. 17 alloys.

MELTING PRACTICE. Lorch, A. Vernon, *"Making High-Quality Magnesium Castings,"* METALS AND ALLOYS, June, 1945, vol. 21, no. 6, pp. 1652-1657.

Proper control of variables in melting practice is of the utmost importance in the production of sound magnesium castings. Foremost among the melting problems is the prevention of contamination of the metal by silicon, lead, copper, nickel, and aluminum, and the loss of manganese. Silicon is picked up when molten magnesium at temperatures above 1600° F. comes into contact with sand. Lead, copper, nickel, and aluminum are readily picked up by molten magnesium and hence should be kept out of the foundry insofar as possible.

Also of importance are the practices of superheating and heat treating to secure the desired physical properties. The author has found that smooth test bars give higher test results than rough test bars. Apparently the roughness produces a "notch effect."

METALLOGRAPHIC TECHNIQUE. *(See Metallography.)*

MICROSHRINKAGE. Van Brunt, Robert, *"Combatting Microshrinkage in Casting Magnesium,"* ALUMINUM AND MAGNESIUM, May, 1945, vol. 1, no. 8, pp. 28, 34.

In an effort to combat microshrinkage, the author's company has turned to the use of an alloy having more aluminum, less zinc, and lower impurities than the conventional American magnesium-base alloys. The alloys adopted have shown less tendency toward microporosity and better flowability and casting characteristics. Experiments indicated that microporosity increases with the zinc content.

The possibility of using alloys with little tendency toward microshrinkage should eliminate the need for impregnating castings.

Although it is thought that an increased zinc content increases the susceptibility to corrosion, this action can be counteracted by keeping the impurities at an absolute minimum.

PART FAILURES. George, P. F., *"Fracture Characteristics of Magnesium Castings,"* ALUMINUM AND MAGNESIUM, June, 1945, vol. 1, no. 9, pp. 14-17.

When a magnesium casting fails in service, the failure is usually due to poor design, metallurgical defects, or improper use. By examining the fracture of a part which failed because of poor design or improper use, one can determine whether the failure occurred in tension, impact, torsion, shear, compression, or fatigue.

The author describes the appearance of a fracture occurring under each type of stress and illustrates the fractures with photographs or photomicrographs. At the end of the article he presents a table which summarizes the fracture characteristics of magnesium alloys in the as-cast, heat-treated, and heat-treated and aged condition.

WELDING. *(See Salvage of Castings.)*

Malleable Iron

HIGH STRENGTH. Albrecht, W. M., *"Strong, Light Iron Castings,"* METALS AND ALLOYS, June, 1945, vol. 21, no. 6, pp. 1631-1636.

A description of an alloy known as "Z-Metal," which is structurally a cross between a pearlitic malleable iron and a spheroidized high-carbon steel. The microstructure consists of temper carbon nodules and hard spheroidized cementite particles imbedded in a ferrite matrix.

The author describes the process for making the alloy, the engineering properties of the metal, some of its special-service properties, its fabricating features, and gives some of its applications.

PEARLITIC MALLEABLE. Wiggins, C. R., *"Controlled Spheroidization of Pearlitic Malleable Iron,"* THE IRON AGE, May 10, 1945, vol. 155, no. 19, pp. 78-81.

The spheroidization of steel and of malleable iron are different, inasmuch as in steel no spheroids are present in the final structure, while in pearlitic malleable iron spheroids are present in the final structure.

Pearlitic malleable iron is produced by treating white cast iron at high temperatures to convert all carbon not in solution to temper carbon; air quenching to convert all carbon in solution to pearlite, and a final spheroidizing treatment to spheroidize the pearlite. Graphitization is controlled by silicon and manganese. Silicon promotes graphitization and manganese retards it. The heat treating cycle is described in detail.

Along with the article is a spheroidization chart which may be used as a standard for size and number of spheroids.

THERMAL LAG. *(See Heat Treatment.)*

Mechanical Handling

SLINGS. *"Lifting Slings,"* MECHANICAL HANDLING, April, 1945, vol. 32, no. 4, pp. 210-211, 230.

Advice on methods of slinging, the construction of sling ropes, and the care and testing of slings.

Metallography

MAGNESIUM-BASE ALLOYS. *"Magnesium Alloy Metallography,"* THE IRON AGE, February 1, 1944, vol. 155, no. 5, pp. 58-59.

An outline of the methods for polishing and etching specimens of magnesium-base alloys, and a description of the principal microconstituents in these alloys.

POLISHING. Prance, S. R., *"Electropolishing of Steel for Microscopic Examination,"* STEEL, April 23, 1945, vol. 116, no. 17, pp. 106, 109.

Description of the methods and equipment used for electrolytic polishing of steel specimens for microscopic examination.

Non-Ferrous Alloys

SHRINKAGE AND GAS. *(See Shrinkage.)*

Pattern Equipment

DESIGN. Hoult, F. H., *"The Development and Application of Pattern Equipment for the Production of a Light Alloy Casting,"* FOUNDRY TRADE JOURNAL, May 31, 1945, vol. 76, no. 1502, pp. 89-95, 97.

The type of pattern equipment developed for a particular casting depends upon a number of factors, such as the total number of castings to be produced from the pattern equipment, the time in which the first castings are required, the facilities available, and the required rate of production.

The author of this article has selected a light metal part, for which he describes the development of pattern equipment. His discription includes the temporary wood patterns for the production of the first castings used for experimental purposes; the metal pattern equipment used for production work; and all core boxes used for the job.

SHORT-RUN PATTERNS. McLaughlin, J. N., *"Casting Short-Run Variable Designs,"* THE IRON AGE, April 19, 1945, vol. 155, no. 16, pp. 67-70.

A pictorial record of a method of interchanging patterns on match plate mountings in order to enjoy the advantages of match plate equipment without incurring the high cost of manufacturing standard match plate equipment. Patterns mounted in this way are suitable for the production of castings in small quantities.

Permanent Molds

BRITISH PRACTICE. Wheeler, Jack W., *"British Permanent Molding,"* MODERN METALS, June, 1945, vol. 1, no. 5, pp. 14-19.

The first of a series of articles describing the early history, development, and present day practices in the use of permanent molds in England.

Pyrometry

IMMERSION THERMOCOUPLE. Tucker, R. C., *"The Immersion Thermocouple in the Grey-Iron Foundry,"* FOUNDRY TRADE JOURNAL, April 26, 1945, vol. 75, no. 1497, pp. 335-341.

The author describes an adaptation of the platinum/platinum-rhodium thermocouple which may be used in controlling casting temperatures in grey iron and steel foundries.

Temperature readings taken with an immersion thermocouple are more accurate and more consistent than readings taken with an optical pyrometer. Time required for taking temperature readings is short. The instrument can be quickly and easily repaired, and the cost is not excessive. The thermocouple consists of platinum and platinum - rhodium elements, protected by a thin silimanite sheath, connected to a potentiometer by means of compensating leads. Each thermocouple should be standardized before using it for actual temperature measurements.

The use of the immersion thermocouple permits the use of cooling curves and inverse rate curves of various alloys as a control measure. Such curves give much useful information about an alloy in much less time than a laboratory could supply a full analysis.

Radiography

FOUNDRY DEVELOPMENT. Jackson, R., *"The Application of Radiography to the Improvement of Foundry Technique,"* THE IRON AND STEEL INSTITUTE, Advance Copy, January, 1945, Paper No. 13/1945 of the Steel Castings Research Committee. 35 pp.

The principles involved in the taking and interpretation of a radiograph of a casting are given and the nature and extent of the defects which are revealed are discussed.

Examples are given of the application of radiography to the examination of steel castings and of the methods adopted to improve the quality of castings thus examined. Tests carried out on steel castings improved by these means have shown their strength to be much greater than had been previously recognized.

SAFETY CODES. *"Safety Code for the Industrial Use of X-rays,"* INDUSTRIAL RADIOGRAPHY, Spring Number, vol. 3, no. 4, pp. 29-34.

This is a reprint of the American Standards Association safety code for the industrial use of X-rays. The code covers safety standards for the installation, operation, use, and maintenance of industrial X-ray equipment, including radium as used for industrial radiography.

Subheadings of the code include definitions, permissible dosage rate, working basis for X-ray protection, general requirements for X-ray installations, control of personnel, health provisions, and basis for planning X-ray protection. Following the code are a number of general comments, comments on the title, and comments on sections of draft which were made by members of the American Industrial Radium and X-ray Society.

STANDARDS FOR CASTINGS. Wyle, Frank S., *"The Use of Static Tests as a Method of Determining the Radiographic Classification of Castings,"* INDUSTRIAL RADIOGRAPHY, Spring Number, 1945, vol. 3, no. 4, pp. 13-20.

Static testing has become an important method of determining standards for radiographic inspection of castings. In this paper, the author has first defined some of the terms used by engineers and designers in connection with the determination of standards. He points out where static testing must be used in connection with specifications and traces the development of classification from the original design to the final classification. He gives examples of some of the static tests which are actually performed and discusses precautions which must be observed in performing these tests.

The author concludes his article by discussing other types of tests which are useful in setting radiographic standards.

Reclamation

METAL. *"Metal Reclamation,"* METAL INDUSTRY, May 11, 1945, vol. 66, no. 19, pp. 293-294.

Non-ferrous foundries lose much metal in the form of dross, skimmings, ash or slags, and floor sweepings. This article describes some of the methods by which they may be reclaimed. Reclamation processes described include crushing, grinding, screening, and concentrating, in preparation for remelting.

Six diagrams illustrate the layout for various reclamation systems.

Safety and Hygiene

MAGNESIUM FIRE HAZARDS. Moulton, Robert S., *"Fire Safeguards for Magnesium,"* ALUMINUM AND MAGNESIUM, June, 1945, vol. 1, no. 9, pp. 20-21, 24, 28.

The combustion of magnesium demands three conditions: a sufficiently high temperature to ignite the metal and support combustion; a supply of oxygen (or some other chemical element) to combine with the magnesium; and a supply of magnesium. In these respects magnesium is no different than any other combustible material. Removal of any of these three essentials will extinguish a magnesium fire.

Next to preventing magnesium fires, a knowledge of the proper method of extinguishing a magnesium fire is most desirable. The particular method used will depend upon the state in which the magnesium is present. Magnesium is more combustible in a state of fine subdivision than in a large mass.

The author recommends fire precautions to be observed during grinding, machining, and storing magnesium. He also discusses the results of tests made by the Chicago Fire Department in extinguishing magnesium fires.

Salvage of Castings

MAGNESIUM. Averbach, B. L. *"Reclamation of Magnesium Castings by Helium Arc Welding,"* METAL PROGRESS, June, 1945, vol. 47, no. 6, pp. 1137-1139.

The author describes techniques and applications of helium arc welding as a means of salvaging magnesium castings. As the result of tests and production practices, the author recommends that for walls ¼ in. and under a preheating of 300° F. should be used. For walls ½ in. and over a temperature of 600 to 700° F. should be used, with 640° recommended for safety. In most cases welds are not permitted if the defect to be repaired is more than half the wall thickness in depth.

Shot Peening

TYPES OF SHOT. *"Shot for Metal Peening,"* Oscar E. Horder and James T. Gow, STEEL, April 2, 1945, vol. 116, no. 14, pp. 111-112, 172.

Shot used in metal peening may be made of chilled iron, malleableized chilled iron, or a special heat treated material. Steel shot is seldom used because of the cost.

Shrinkage

NON-FERROUS ALLOYS. Baker, W. A., *"Shrinkage and Gas Effects in the Casting of Non-Ferrous Metals and Alloys,"* BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION REPORT R.R.A. 661. June, 1944. 44 pp.

A connected account (written in the light of recent researches by the B.N.F.M.R.A.) of shrinkage and gas phenomena during the solidification of metals together with methods of obviating ill effects on castings. The fundamental mechanisms of the processes concerned are explained in terms which do not assume specialized knowledge on the part of the reader. Practical recommendations are given. There is a bibliography of 58 references.

Slags

BASIC OPEN-HEARTH. *(See Steel.)*

Sponge Iron

EXPERIMENTAL PRODUCTION. *"Trial Run Is Made at Sponge Iron Plant,"* STEEL, June 25, 1945, vol. 116, no. 26, pp. 122-123, 166, 170.

A description of the equipment and operation of an experimental plant for the production of sponge iron by means of the reduction of a hematite concentrate in a finely divided condition by coke oven gas. The plant, which is located at Warren, Ohio, is sponsored by the War Production Board.

Steel

BASIC OPEN-HEARTH PRACTICE. Jay, A. H., *"A Study of the Basic Open-Hearth Process, with Particular Reference to Slag Constitution,"* THE IRON AND STEEL INSTITUTE, Advance Copy, April, 1945. 32 pp.

An account is given of experiments carried out to investigate the constitution of basic open-hearth slags in relation to the mechanism of dephosphorization in the furnace and rephosphorization in the casting pit.

The work described involved the X-ray examination and chemical analysis of slag samples taken during the refining period and the casting of the ingots. Differences in constitution were found, depending on the rate of cooling of the slag samples. Changes in bath composition have been studied by means of metal samples taken during the same period. The X-ray work has been supplemented by the examination of oxide mixtures prepared in the laboratory, the results of which have greatly contributed to the interpretation of the slag constitution. A hypothesis has been evolved to relate rephosphorization in the pit to the composition of the tapping slag. A suggestion is made to explain the mechanism of dephosphorization in the furnace.

CASTINGS VS. FORGINGS. Sims, C. E., *"Cast and Forged Steels Compared,"* STEEL, June 4, 1945, vol. 116, no. 23, pp. 113-114, 116, 152, 154.

The author reports on the comparison of the physical properties of parts made from steel castings and from steel forgings. Parts compared were forged and cast cylinder barrels; forgings and parts made from cast forging blanks, and seamless tubing from centrifugally castings and from pierced billets.

The author's studies showed that there was little difference in properties of forgings and sound castings as a whole, although forgings did have directional properties. It was also shown that cast forging blanks which required only one or two stampings had properties which compared very favorably with those of forgings and yet required fewer and less expensive forging operations.

MOLYBDENUM SPOT TEST. *(See Chemical Analysis.)*

OPEN HEARTH. *"Slag Control,"* N. H. Bacon, IRON AND STEEL, March 1945, vol. 18, no. 3, pp. 86-90.

A detailed discussion of methods for adjusting the silicon, phosphorus and sulphur by means of slag control.

Time Study

APPLICATIONS. Stearns, Ralph A., *"Managerial Use of Time Study,"* THE IRON AGE, April 19, 1945, vol. 155, no. 16, pp. 71, 146, 148.

In this article the author ignores the use of time study for rate setting purposes and discusses the other services which time study engineers can perform for industry.

Welding

MAGNESIUM-BASE ALLOYS. *(See Salvage of Castings.)*

BOOK REVIEW

Covers Practical Patternmaking

Practical Wood Patternmaking, by J. Robert Hall. Blue cloth bound, 8½x11, 188 pages, 264 illustrations, numerous reproductions of drawings and blueprints. Published in 1943 by McGraw-Hill Book Company, Inc., New York. Price $3.00.

This textbook was designed for use in vocational and technical schools and in apprenticeship training. In it the author says ". . . the beginner must acquire the following fundamentals if he is to become a good mechanic: (1) The proper handling of woodworking tools. (2) A thorough knowledge of molding and core making. (3) The ability to read complicated blueprints.

"Without this training a man cannot become a good patternmaker."

Safety Suggestions Good

The author has done an excellent job in handling item (1). His descriptions of tools and power machines, his directions and safety suggestions for their use, and his comments on their care and upkeep are very good.

His descriptions of woodworking skills and pattern layout are likewise good.

His exercises in the construction of various types of patterns and core boxes are accompanied by a careful selection of drawings and blueprints such as would confront a patternmaker in a shop.

The author's treatment of items (2) and (3), however, is not quite so good. In attempting to present the reading of blueprints in as simple a manner as possible, he has skipped many important facts which a good patternmaker should be acquainted with. In order to get the greatest good out of this book, a student should precede its use with a course in engineering drawing.

In the section on general information on blueprints, the author says that if a drawing is to be scaled for dimensions, a standard scale should be used. Scaling a drawing or a blueprint for dimensions is poor practice at any time, and the suggestion that it may be done certainly should not be made to an apprentice patternmaker.

Foundry Practice Faulty

As for the author's presentation of foundry practice and core making, many of his statements would give an uninformed reader the wrong impression.

In the beginning of the book the author implies that wood patterns are the only patterns of any consequence in a foundry. Nowhere in the book has he mentioned that metal patterns are used for most production work, and that one of the principal types of wood patterns is the master pattern, constructed with double shrinkage allowance, for the purpose of making a metal pattern or patterns.

At times the author fails to make use of or explain facts which he has introduced in the text. For example, on page 30 he has made the following statement about the preparation of shellac: "For this work, shellac, alcohol, lamp black, oxalic acid, shellac pots, brushes, and a container are needed." The author goes on to explain how shellac should be prepared. When he has finished the explanation, the student is left wondering what to do with the lamp black, since no further mention of it is made.

The outstanding omission of the textbook is the failure to emphasize the importance of the patternmaker consulting and cooperating with the foundryman. The author permits the student to believe that all decisions concerning how a pattern is to be made and molded rest with the patternmaker. This should never be the case, regardless of how good a foundryman the patternmaker may be. Failure of the foundryman and the patternmaker to discuss a pattern before it is made and used is responsible for many of the defects which result in scrap castings. Any instructor using this book as a text book should impress the student with the need for interdepartmental cooperation.

New Products

Electric-Type Potentiometer Controller

Announced by *The Bristol Co.,* Waterbury, Conn., a new series of electric-type potentiometer controllers of five basic unit types. The series includes electric contact and electric proportioning and current-input types. The current-input controller is primarily designed for temperature control of electric furnaces and ovens.

Band Saw Tooth Lubricant

Manufactured by *Kindt-Collins Co.,* Cleveland, is a lubricant for band saw teeth, prepared in the form of a stick 6-in. long and 1-in. in diameter. When used on a metal-cutting saw, the lubricant makes cutting easier and faster.

Wire Belt Hooks

The Bristol Co., Mill Supply Div., Waterbury, Conn., has added a line of hinged-type wire belt hooks to its belt lacing products. These new hooks are designed for joining all types of flat belting, including leather, fabric, rubber and balata belts. Sizes include hooks large enough to join belts ⅜-in. thick.

Oil Mist Collector

Recently developed by the *American Air Filter Co., Inc.,* Louisville, Ky., is a self-contained, electronic unit to collect oil mist from high speed cutting tools or welding fumes in light concentrations. An axial flow fan mounted on top of the

(Continued on Page 94)

THE LAST DROP IS AS GOOD AS THE FIRST

They Look Alike...

BUT ONE'S A GENUINE DIAMOND

It takes an expert to tell the value of a genuine diamond . . . you can't tell much from appearance. You can't tell much about Core oil either, from its looks . . . PERFORMANCE, not price, counts! DAYTON OIL is doing a real job in many of America's leading foundries. The uniform, unvarying quality of this fine oil assures uniform results. Let's talk it over.

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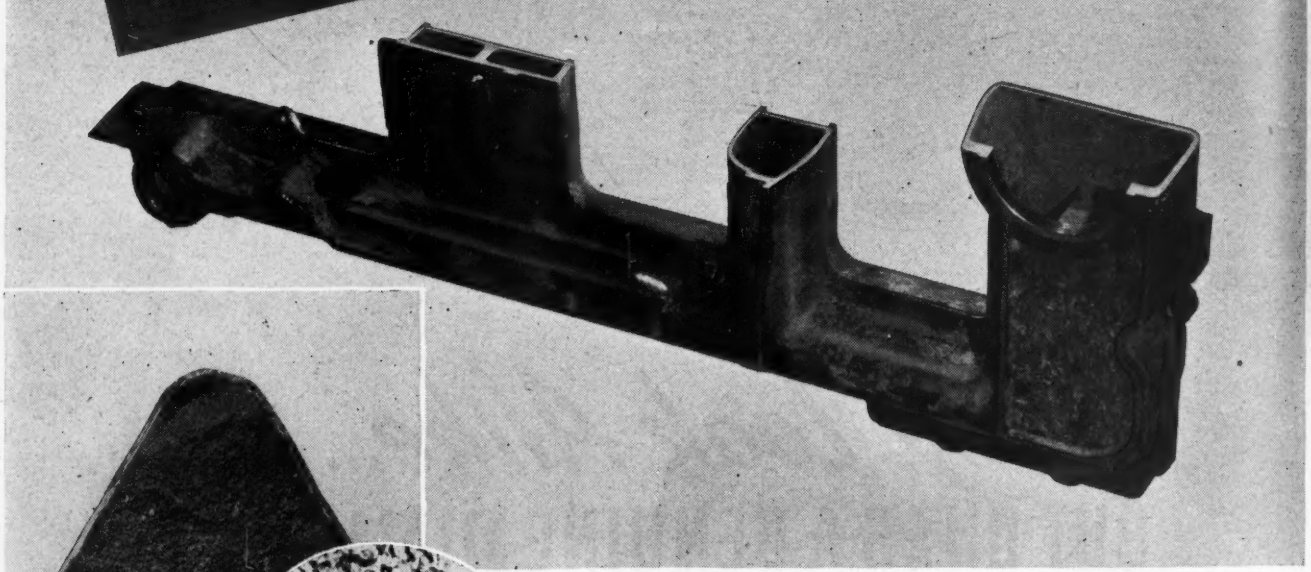
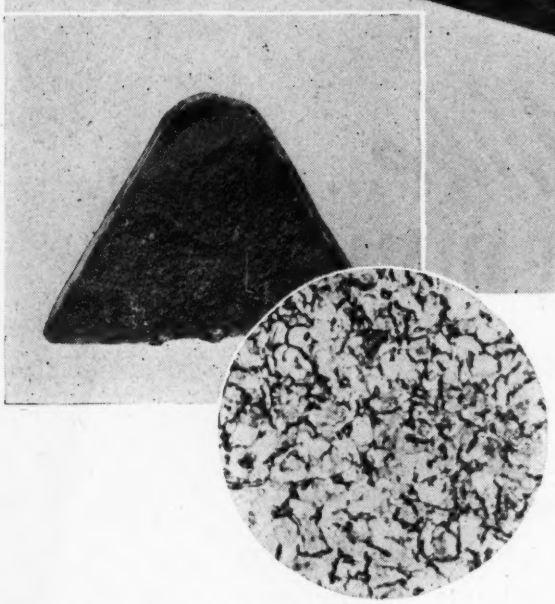
STEEL CORE AND MOLD WASHES - BINDER AND CORE PASTE - CORE WASHES - CHILL COATINGS

G-IRON* helps solve the problem of casting thick and thin sections





Greater fluidity of G-Iron and reduction in internal shrinkage help solve the problem of casting thick and thin sections without the danger of cold shuts and shrink pockets. Reduces scrap losses.

*G-Iron is graphitized pig iron. The photographs show its grain structure. The Photomicrograph (circle, etched, 500 diam.) shows the random graphite evenly distributed. Manufactured under U. S. and Canadian patents.

TONAWANDA IRON CORPORATION

NORTH TONAWANDA, N. Y.

Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

Scrap Heap into "Treasure Trove"

How RADIOGRAPHY reclaimed $35,000 worth of castings from an $840 scrap pile

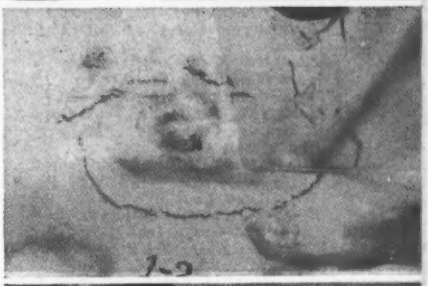
Almost as dramatic as a Yukon "gold strike," here's a case history of radiography speeding production . . . rescuing $35,000 worth of castings from the scrap pile . . .

Costly, complicated to cast, these 40-pound housings demanded—and received—the most precise casting technics. But in spite of all precautions, flaws were unavoidable . . . deliveries fell behind requirements.

The suggested remedy was repair welds. But how could they be proved sound?

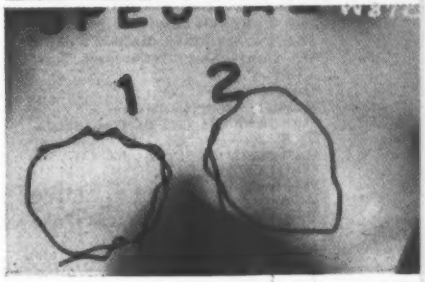
How? The foundry used radiography to locate the internal irregularities . . . then made the welded repairs and x-rayed them. Study of the new radiographs showed the repaired castings to be acceptable. The 350 castings which were thus salvaged each month brought deliveries up to schedule—with a monthly saving of thousands of dollars.

This case history—repeated in many industries—shows how radiography serves as a design and improvement tool . . . as well as an inspector. Tremendously increasing industrial output, under rigid inspection standards, radiography has more than "won its wings." Tomorrow, it will be an even greater *must*. Why not investigate its possibilities for you, *now?* See your local x-ray equipment dealer.



Investigation discloses irregularity. A flaw typical of those which slowed the foundry's deliveries on these complex housings.

Welding repairs the condition . . . BUT: Is the weld sound, is penetration satisfactory and metal well fused? Will the casting meet inspection requirements?



Radiography approves the repair: "Yes," says this radiograph—welding has made the rejected casting sound, sturdy, acceptable—and ready to use.

EASTMAN KODAK COMPANY, *X-ray Division,* Rochester 4, N. Y.

RADIOGRAPHY

ANALYZES . . . INSTRUCTS . . . CORRECTS . . . IMPROVES

Kodak

ANNUAL BUSINESS MEETING

(Continued from page 22)

For the presentation of the Joseph S. Seaman Gold Medal to A.F.A. Secretary Robert Edwin Kennedy, Mr. Wilson introduced National Director H. S. Simpson, who outlined Bob Kennedy's long career of service to the Association and to the industry. "No man," he said, "has done more to foster and inspire the industry with a sense of its real value and abilities than has Bob Kennedy."

The Seaman Medal award was made *"for outstanding meritorious service to all branches of the Foundry Industry through his work in organizing and guiding the development of technical and operating papers and discussions, and his untiring encouragement to all A.F.A. Chapters, committees and members."*

Honorary Life Membership in A.F.A. was presented, in absentia, to Rear Admiral A. H. Van Keuren, U.S.N., Director of the Naval Research Laboratory, Washington, D. C., *"in recognition of his efforts in behalf of the Foundry Industry."* Admiral Van Keuren found it impossible to attend at the last minute, and it is hoped that the presentation can be made to him in person at a meeting of the Chesapeake Chapter this fall.

Honorary Life Membership was presented to M. J. Gregory, retired, formerly Factory Manager of Caterpillar Tractor Co., Peoria, Ill., *"for his contribution to the Association and the Foundry Industry."* Mr. Wilson made the presentation and Mr. Gregory, a past National Director of the Association, in his response gave special recognition to the valuable assistance given foundrymen by the equipment and supply men.

Honorary Life Membership was presented to retiring President Ralph Teetor, and in doing so Awards Chairman Wilson paid tribute to the quality of leadership A.F.A. has had under the guidance of President Teetor, in laying the foundation for greater service to the entire industry.

Foundation Lecture

Owing to sudden business urgencies, the 1945 Foundation Lecturer, Dr. H. A. Schwartz, Manager of Research, National Malleable & Steel Castings Co., Cleveland, found it impossible to attend. In his absence, an excellent digest of Dr. Schwartz' lecture on "Solidification of Metals" was presented by Fred G. Sefing, International Nickel Co., New York. Copies of the lecture have been distributed to all A.F.A. members, as an outstanding addition to the literature on castings research.

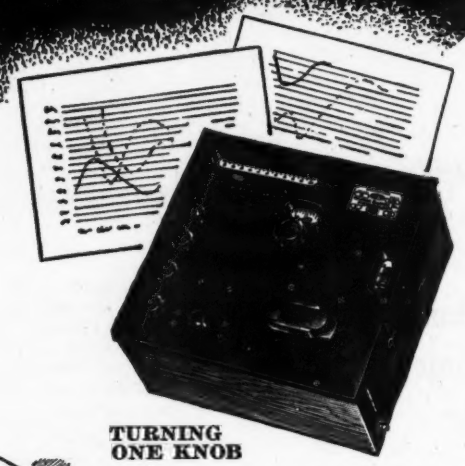
Secretary Kennedy announced the winners in the National Apprentice Contests of A.F.A., this year including entries in gray iron, steel and brass and bronze molding, and in patternmaking. The complete list of winners is presented in a separate article in this issue.

Van Billiard Dies

ERNEST N. Van Billiard, Progressive Foundry, Inc., Rochester, N. Y., passed away at a Rochester hospital recently after an illness of some duration. The deceased was a member of the Rochester chapter and was a past director of that chapter.

"...speeded up our work 3 times"

the UNIVERSAL Spectrophotometer



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U. S. Rubber Co.
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Western United Gas & Electric Co.
Wisconsin Steel Works
The Youngstown Sheet & Tube Co.

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USERS REPORT

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" . . . refinery, it is effecting a saving of five to six man-hours each day."
" . . . steel tests, we would have had to add at least one experienced chemist."
" . . . speeded up our work three times. All problems were referred to us by the National Research Council."

Write for Bulletin AF 845 and ask for information about new procedures.

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ON INGOT BRASS AND BRONZE

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The high regard of foundrymen for H. Kramer and Company and its products is a time-honored confidence . . . a confidence which has been upheld and reaffirmed for more than half a century.

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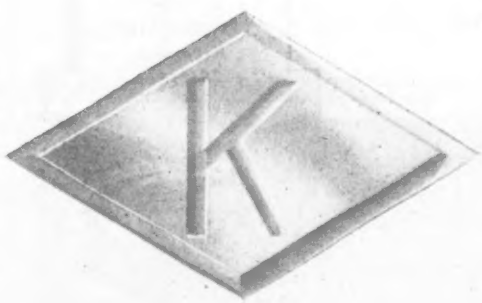

Some "Falls Brand" Aluminum Alloys

Aluminum Calcium
Aluminum Chrome 85/15
Aluminum Chrome 90/10
Aluminum Copper 50/50
Aluminum Copper 60/40
Aluminum Copper 80/20
Aluminum Copper Nickel 50/25/25
Aluminum Copper Silicon 50/25/25
Aluminum Iron 50/50
Aluminum Iron 80/20
Aluminum Magnesium 90/10
Aluminum Magnesium 98/2
Aluminum Manganese 75/25
Aluminum Manganese 80/20
Aluminum Manganese 90/10
Aluminum Manganese 95/5
Aluminum Manganese, Metallurgical Grade
Aluminum Nickel 80/20
Aluminum Nickel Copper 50/25/25
Aluminum Shot
Aluminum Silicon 50/50
Aluminum Silicon 75/25
Aluminum Silicon 88/12
Aluminum Silicon Copper 50/25/25
Aluminum Solder
Aluminum Titanium
Aluminum Vanadium
Aluminum Zirconium

This partial list is but a few of the many alloys we make. Each is for the specific purpose of adding quantities of high melting point metals to standard alloys.

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NIAGARA FALLS SMELTING & REFINING CORPORATION
America's Largest Producers of Alloys
BUFFALO 17, NEW YORK

New Products

(Continued from Page 88)

unit draws air from the operation which is properly hooded through piping into the base of the unit. Applied to cutting operations, the mist-laden air first passes through a

A self-contained, electronic unit built to collect oil mist.

permanent unit filter to remove any metallic dust or large drops of oil, then enters the ionizer in which the mist and smoke particles receive an electrical charge before passing into the collector unit where they are precipitated on the plates.

A removable panel gives full access to all parts without tools of any kind. Operator is protected from any possible shock since turning the latches to remove the panel shuts off the current.

Dual Cross Belt Magnetic Separator

Dings Magnetic Separator Co., Milwaukee, has designed and built a high intensity dual cross belt electro-magnetic separator to remove the finest trace of iron from non-ferrous borings.

Material is distributed from a hopper onto the first main belt. Material passes through a first and second magnetic zone, magnetic particles are lifted up by the upper magnets and pushed up by the lower ones. The magnetic particles are held fast

(Continued on Page 97)

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Stevens

STAMPED STEEL LADLE BOWLS

are the best . . . there isn't another ladle bowl made that compares with them.

NO SEAMS ★ NO WELDS ★ NO RIVETS

CHECK THESE FACTS

★ Every one of these bowls is deep-drawn from a single sheet of SPECIAL ANALYSIS EXTRA HEAVY STEEL.

★ Uniform in size and shape.

★ First cost is no more than for ordinary bowls . . . Ultimate cost is much less.

★ For jobs which require a flat, wide stream of metal, use Stevens Style "S" Ladle Bowl. The pouring lip can be formed in the lining and the stream of metal made to suit the job.

OUR LADLE EQUIPMENT LINE IS COMPLETE

★ Whatever type of bowl your work requires, we can supply your needs in various sizes and capacities. Our complete line includes:

BUGGY LADLES ★ TROLLEY LADLES

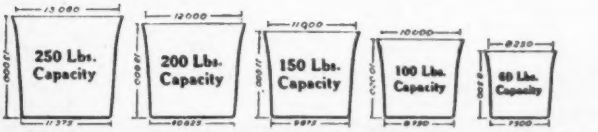
WORM-GEARED LADLES

CRANE LADLES

MIXING LADLES

STEVENS — EVERYTHING FOR A FOUNDRY — DETROIT MICHIGAN

SPECIFICATIONS — PRICES



Made of 5/32" Steel	Made of 1/8" Steel	Made of 1/8" Steel	Made of 1/8" Steel	Made of No. 14 Gauge Steel
$4.25	$3.00	$2.50	$2.25	$1.35

STEVENS STYLE "S" STAMPED STEEL LADLE BOWL

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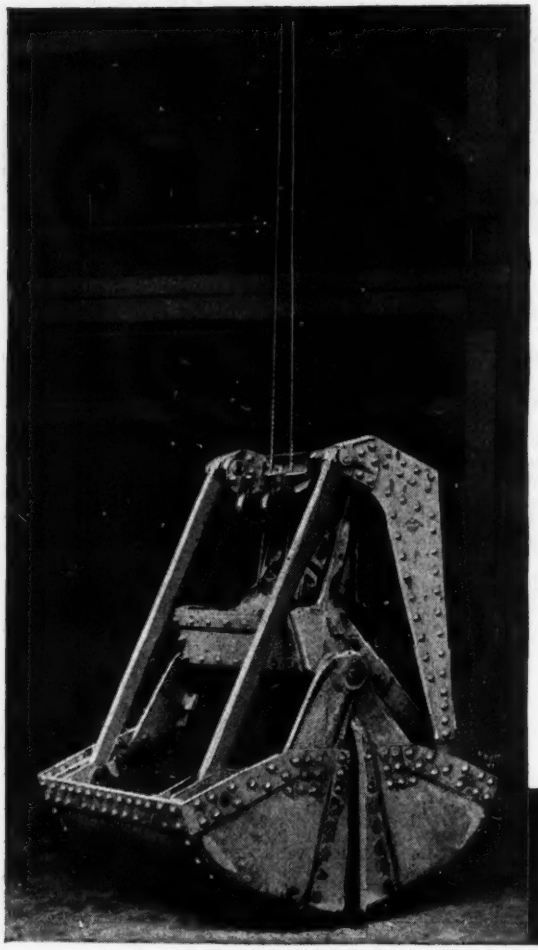

Not Adapted to—but DESIGNED for FOUNDRY USE

Any foundryman who investigates the Blaw-Knox line of buckets can tell that a thorough study of foundry requirements has gone into their design . . . There's a wide variety of Single Line, Hook-on types for both low headroom and extremely low headroom installations . . . Check your requirements and operating conditions against Blaw-Knox specifications and you'll come up with the bucket that's exactly right for the job.

BLAW-KNOX DIVISION OF BLAW-KNOX COMPANY
2073 FARMERS BANK BUILDING, PITTSBURGH, PA.
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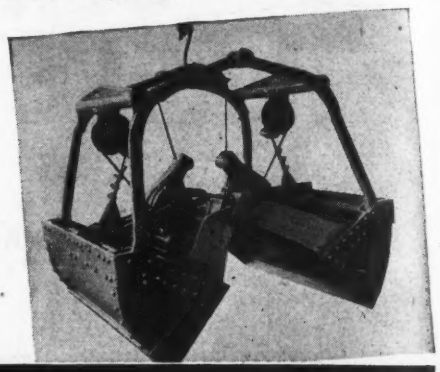
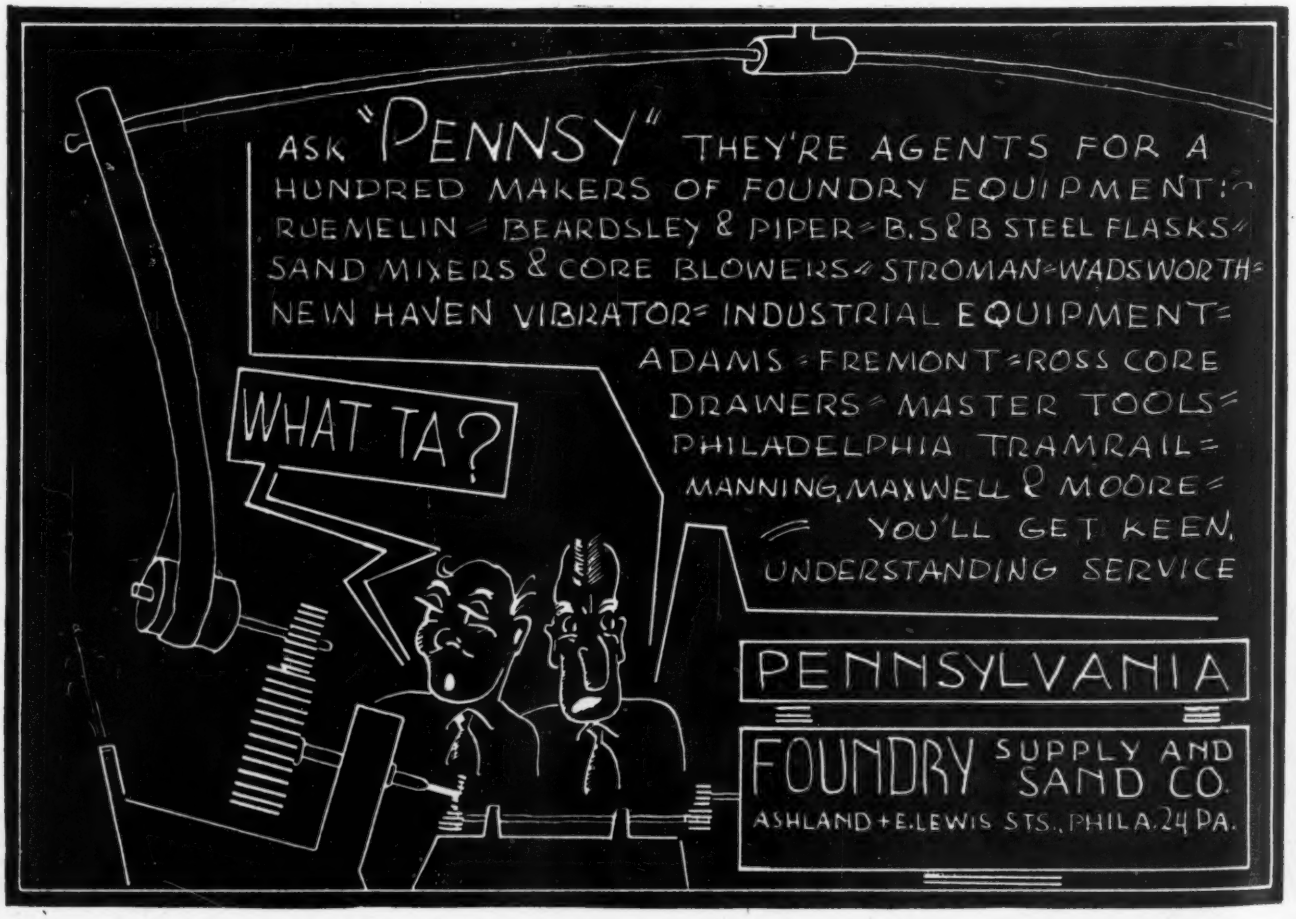
Representatives in Principal Cities

◀ No. 3125 Single Line "closed head" Hook-on Type bucket. Safety hub trip. Concealed hinge stops. Capacity 1½ cu. yds.

No. 309-F. A ¾ cu. yd. Hook-on Type ▶ bucket designed especially for Foundry use. Requires only 6'-7" operating headroom . . . For complete data on these and other Blaw-Knox Buckets for the Foundry, write for Catalog No. 2002.



BLAW-KNOX BUCKETS


ASK "PENNSY" THEY'RE AGENTS FOR A HUNDRED MAKERS OF FOUNDRY EQUIPMENT:
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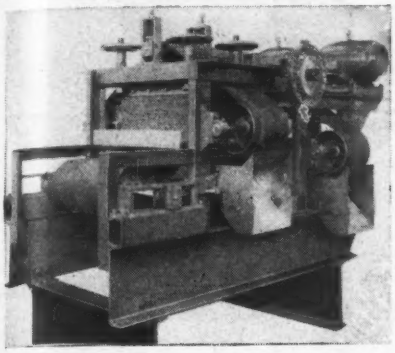
New Products

(Continued from Page 94)



Magnetic separator designed to remove the finest trace of iron from non-ferrous borings.

to the under surface of the first cross belt which carries them beyond the magnetic influence to be discharged at the side.

The first main belt discharges onto the second main belt, at which point the material is turned over. It is then subjected to another magnectic treatment in the third and fourth magnetic zones.

Disc Grinder

Kindt-Collins Co., Cleveland, has developed an all-purpose disc grinder for any type metal, wood or plastic material. Made in two similar models, regular and heavy-duty. Hydraulic controls eliminate all gears, worms and jack screws used for raising, lowering and tilting the table. A handwheel controls every hydraulic operation. The motor is equipped with three V-belts thus making possible highly accurate speeds for efficient grinding.

All purpose disc grinder for grinding metal, wood or plastic.

Feeding Compounds

Foundry Services, Inc., New York, has announced a line of feeding compounds especially developed for use with non-ferrous metals and alloys. Their object is to assist the production of sound adequately fed, pressure tight castings. These feeding compounds act automatically and require the minimum amount of attention; they retain the metal in liquid state longer, thereby assisting considerably in directional solidification; and they are simple to use.

Fire-Resistant Chemical

General Detroit Corp., Industrial Division, Detroit, announces a new fire-resistant chemical for treating foundry molds. This liquid reduces the danger of fire in molds by making the wood fire-resistant. Solution is absorbed into the wood, and does not change the dimensions of the mold.

Combustion Furnace

A new combustion furnace devised by *Harry W. Dietert Co.*, Detroit, is a complete furnace unit for efficient and rapid combustion of iron, steel, or alloy steel samples as

(Concluded on Page 98)

SCHUNDLER
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- A laboratory controlled, first quality product especially "tailored" for Foundry Use
- Offered by a pioneer producer
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- ALUMINUM BRONZE

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- Core and Mold Washes.
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- Refractory Parting Compound for All Ferrous and Non-Ferrous Metals.

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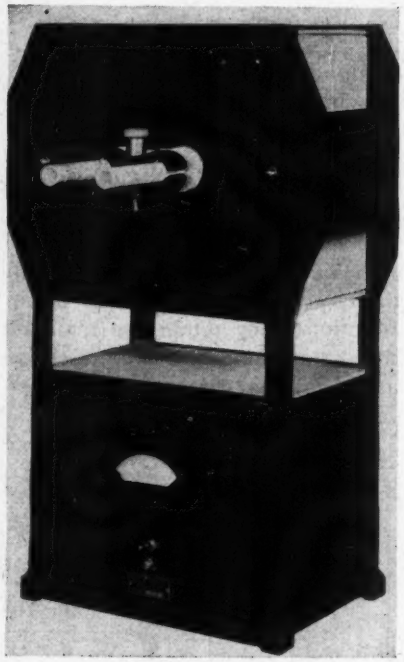
New Products

(Continued from Page 97)



A combustion furnace used for volumetric carbon determination.

used for volumetric carbon determination with a carbon determinator. The furnace is constructed so that all of the required accessories are housed in a separate, well ventilated and protected compartment. A platinum - platinum 10% rhodium thermocouple is used for temperature measurement.

Fillet Cement

Kindt-Collins Co., Cleveland, has developed a waterproof fillet cement for patternmaking. It can be used for leather, wood and plastic fillets, and on wood or metal patterns.

Laboratory Oven

A compact and self-contained oven, built and designed by *Industrial Oven Engineering Co.,* Cleveland, has been made for laboratory and pilot plant use. Temperatures range up to 900°F. Usually furnished with electrical heating equipment, but is designed to use any type of fuel. Designed for precision experimental work in drying, heat treating or polymerizing.

Cleansing Cream

Dennis Chemical Co., 2701 Papin St., St. Louis, has developed a cleansing cream for removing lacquer, paint, enamels, resin solutions and ink from the hands.

Foundry Sand Testing HANDBOOK

A foundryman man select his scrap with the greatest of care. His melting procedure may check with the most advanced practice. And he may exercise full control over his methods. BUT . . . he cannot consistently produce sand castings in molds prepared from uncontrolled sand mixtures.

A casting is only as good as the mold . . . that's why the **A.F.A. FOUNDRY SAND TESTING HANDBOOK** is a "must" for the foundryman's library. Order your copy today: **$2.25 to A.F.A. Members; $3.50 List Price.**

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222 W. Adams St., Chicago 6

A New A.F.A. Publication . . .

Recommended Practices for NON-FERROUS ALLOYS

Information contained in this important New A.F.A. publication has been compiled by the Recommended Practices Committee of the A.F.A. Brass and Bronze Division, and the Committees on Sand Casting of the A.F.A. Aluminum and Magnesium Division. A book that provides non-ferrous foundrymen with accurate, up-to-date data for the production of practically any non-ferrous alloy casting, and enables them to check present production practices against accepted standards and wide experience. An indispensable reference work wherever nonferrous metals are cast . . . compiled by many leading foundrymen and metallurgists. Contains 159 pages, 42 tables, 35 illustrations; cloth bound.

Some of the VALUABLE INFORMATION in this book . . .

Molding Practice . . . Finishing Practice . . . Melting and Pouring . . . Heat Treatment . . . Causes and Remedies of Defects . . . Properties and Applications . . .

for the following alloys:

● Leaded Red and Leaded Semi-Red Brasses. ● Leaded Yellow Brass. ● High-Strength Yellow Brass and Leaded High-Strength Yellow Brass (Manganese Bronze). ● Tin Bronze and Leaded Tin Bronze. ● High-Lead Tin Bronze. ● Leaded Nickel Brass and Bronze Alloys (Silicon Bronze). ● Aluminum Bronze. ● Aluminum-Base Alloys. ● Magnesium-Base Alloys.

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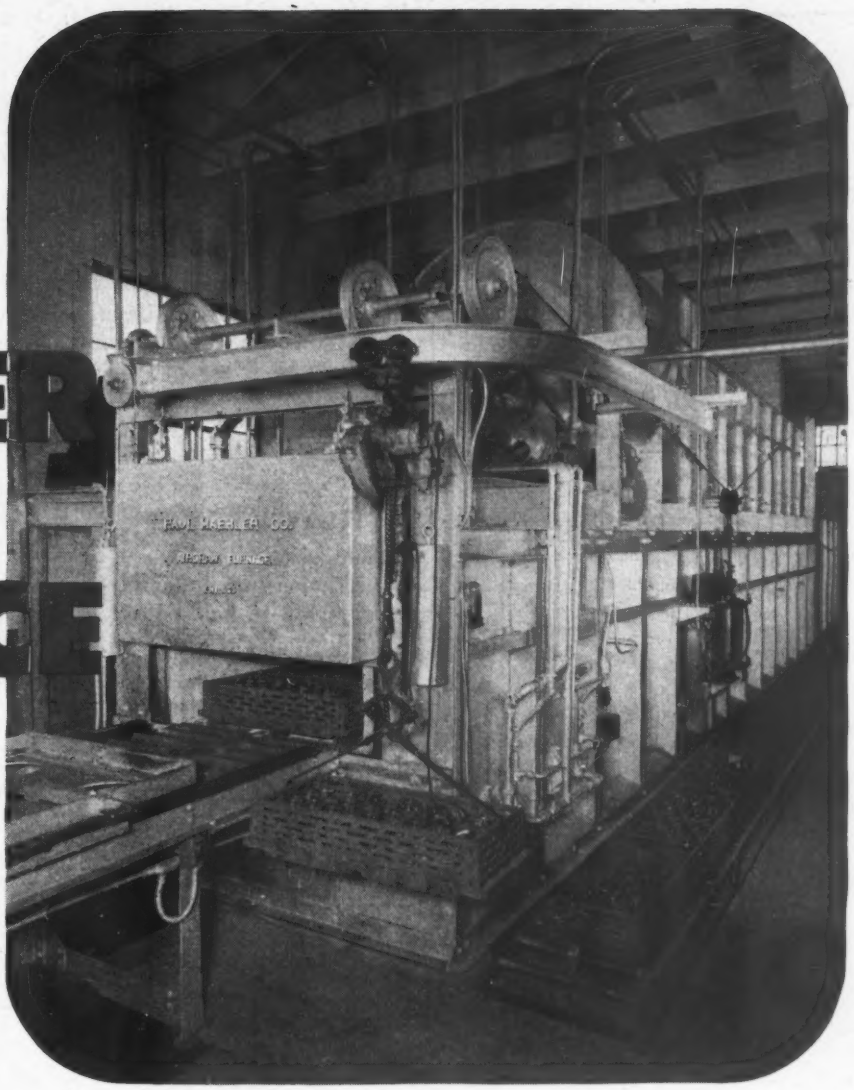
annealing 2,000 lbs. of castings per hour with a

MAEHLER *air-draw* FURNACE



The Maehler air-draw furnace at Chambers, Bering, Quinlan Co. used for annealing gray iron castings. This view shows the loading end of the furnace and the return roller conveyor. Furnace accommodates 38 trays 17" x 36" x 6". As one tray enters, one is pushed out at unloading end of furnace.

This Maehler *built-for-the-job* heat treating furnace maintains temperature uniformity within 2° F.!

ANNEALING gray iron castings contribute much to the life of drills, broaches, lathe tools, etc., as well as reducing retooling costs. When the Chambers, Bering, Quinlan foundry decided to anneal its gray iron castings, Maehler engineers were called in. The photo at the right shows the Maehler roller conveyor-type furnace which was installed. Here are the data and specifications of this efficient unit:

- Capacity of furnace 2,000 lbs. of castings per hour.
- Designed to operate at from 800° F. to 1550° F.—gas fired.
- Working space of furnace—4 ft. wide by 3 ft. 2 in. high by 36 ft. 6 in. long.
- Over-all length—including 7 ft. 6 in. pusher loading station and a 12-ft. cooling chamber 57 ft. 6 in.
- Electric robot control panel completely supervises furnace operation.
- Garden City high-temperature fan driven by a 2-speed motor circulates air at high velocity above normal furnace pressure.
- *Soaking* time of gray iron castings — 1.45 hours at 1200° F

MAEHLER ANNEALING CASTINGS MEAN:

- ***INCREASED MACHINABILITY OF CASTINGS***
- ***LOWER RETOOLING COSTS***
- ***FEWER MANHOURS DURING MACHINING OPERATIONS***
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For Alloys of Copper and Nickel
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• Removes aluminum contamination.

Write for samples; make your own test.

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New York, N. Y.
Dept. AF

New Literature

(Continued from Page 78)

ing are reviewed in this booklet.

A booklet giving pertinent data on sand mixers has been prepared by National Engineering Co., Chicago.

Harry W. Dietert Co., Detroit, has prepared a leaflet describing a combustion furnace for running carbon analyses.

The Bristol Co., Waterbury, Conn., has published a folder, bulletin No. OP1502, giving data on a machine running-time recorder.

The Bristol Co., Waterbury, Conn., has a new bulletin, No. 737, describing wire belt hooks.

Bulletin No. PB1226, The Bristol Co., Waterbury, Conn., illustrates a series of electric-type potentionmeter controllers.

The fifth edition of "Manhattan Rubber Products for Industry" compiled by The Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J., is now available upon request.

• COMMITTEE REPORT

Plant Equipment Group Asks for Suggestions

By Chairman Jas. Thomson, Continental Foundry & Machine Co., East Chicago, Ind.

As the foundry industry faces the future problems of the post-war period, the problems of plant and equipment become of increasing importance. Your Plant and Plant Equipment Committee, in the past, has assumed the obligation of collecting interesting and instructive information about plant and equipment. This information has been presented to the industry by means of papers at conventions and other meetings.

We shall endeavor to carry along this work in the difficult period facing us and, therefore, will give serious consideration to any suggestions for papers on these subjects from any of the members of the American Foundrymen's Association.

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The choice of Foundries who demand the best.

"Jisco" Silvery is a "must" in the modern foundry. Its use means better castings at lower cost. It supplies the needed silicon.

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A revised A.F.A. Committee publication of authoritative information on the properties, application and production of alloy cast irons.

This revised edition of the ALLOY CAST IRON book contains a correlation of practical knowledge advanced by outstanding authorities on the production and application of alloy cast irons. The 282 pages of text matter contain 96 tables and 123 illustrations, all dealing with the latest alloy gray iron manufacturing methods.

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This closer control of pouring temperatures is the secret of good castings. Foundrymen everywhere are using Marshall Thermocouples to make certain that all their castings are poured at the correct temperatures. L. H. Marshall Co., 270 W. Lane Ave., Columbus 2, Ohio.

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Thermocouples

Cut-away section showing thermocouple wires swaged into protection tip.
A refractory insulator separates thermocouple wires from walls of tip

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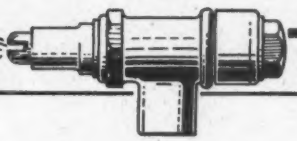
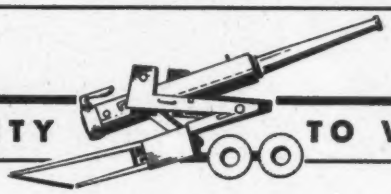
for WEAR-RESISTANCE



STABILITY AT HIGH TEMPERATURES



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Ajax Nickel-Copper 50-50%
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Ajax Aluminum Alloys
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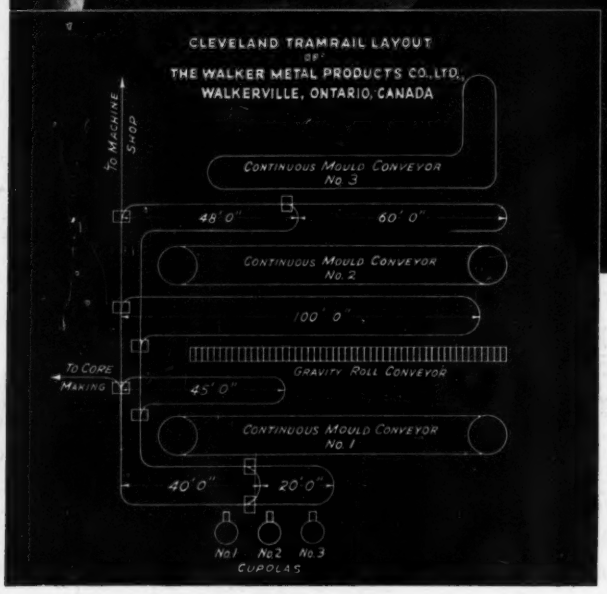

This system is subjected to abrasive dirt, corrosive fumes and high temperatures. It is operated close to maximum capacity at all times, and usually is severely overloaded.

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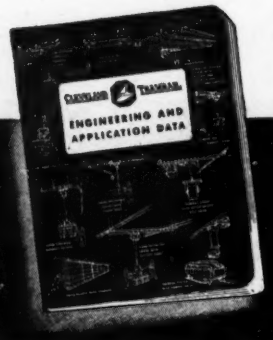
Installed in 1929, the Cleveland Tramrail foundry system at Walker Metal Products Co., Limited, Walkerville, Ontario, Canada, has been worked hard continuously ever since, even through the depression years of 1931-35. Approximately 150 tons of hot metal are conveyed over the main tramrail line daily.

Five one-ton hand-propelled carriers with push-button-operated electric hoists deliver the molten metal directly from the cupolas to the molds on the continuous mold conveyors. The Tramrail System works hand-in-hand with the mold conveyors and makes possible efficient mass production of motor blocks, cylinder heads, and a variety of other castings with minimum labor time per item.

Cleveland Tramrail is quality built and designed to operate successfully under rigorous conditions. Hundreds of foundries are profiting through its use.



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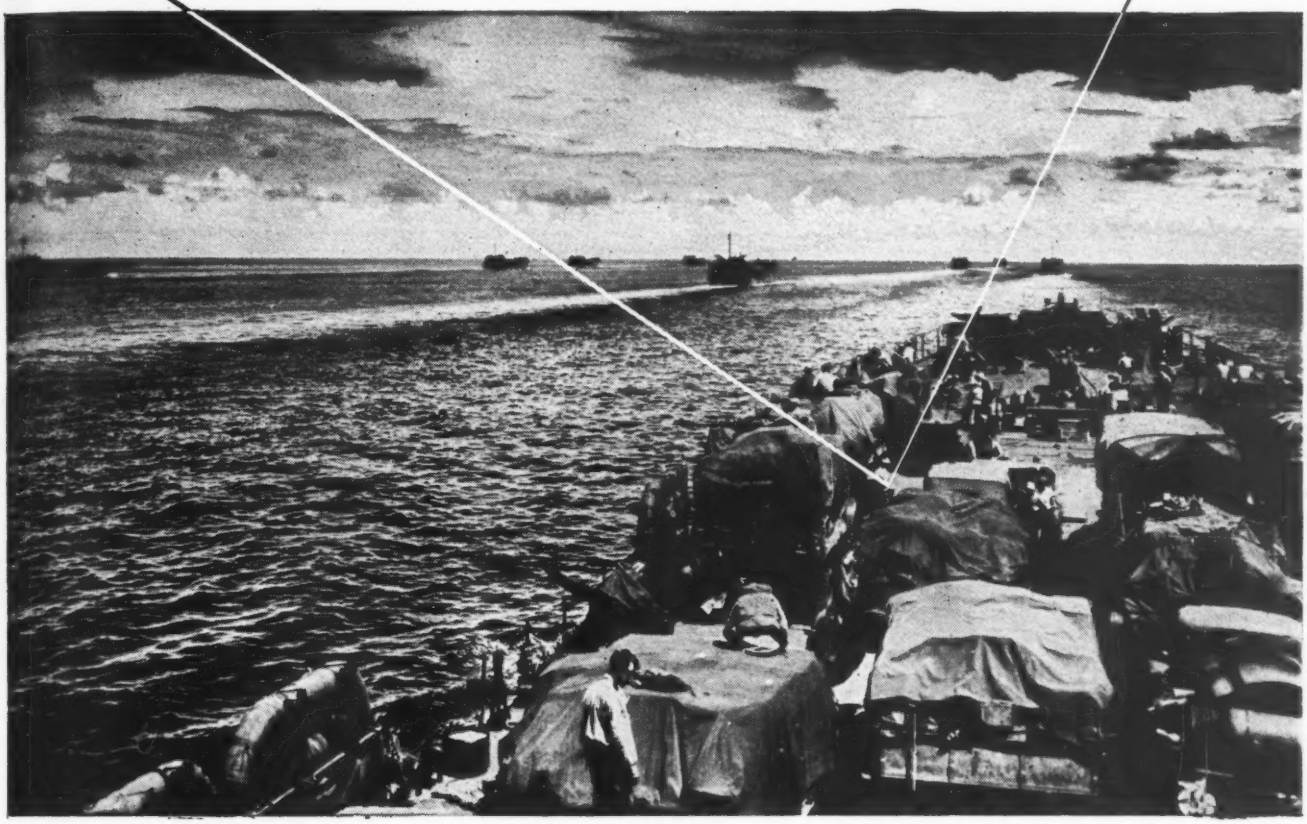


Are You?

Today the veterans of our European victories are sailing to final triumph in the Pacific! Meanwhile patriotic American industrial leaders are following a full-speed-ahead program to hasten peace through the Payroll Savings Plan!

From coast to coast, veteran Bond salesmen—and women—who put over the Mighty 7th, are once more mustered into service for plantwide selective resolicitation campaigns. These special efforts to keep employee Bond buying at a maximum are directed toward two major objectives:

A To hold every new 7th War Loan subscriber on the Payroll Savings Plan books—maintaining and, wherever possible, increasing present Bond allotments.

B To convince all regular subscribers who recently stepped up their Bond buying, of the many advantages of continuing on this foresighted, extra-Bonds-for-the-future basis.

Back up our fighting men who have won one war—and will win another. Use selective resolicitation to make your Payroll Savings Plan more effective—put a tighter rein on inflationary tendencies—build peacetime prosperity.

The Treasury Department acknowledges with appreciation the publication of this message by

AMERICAN FOUNDRYMAN

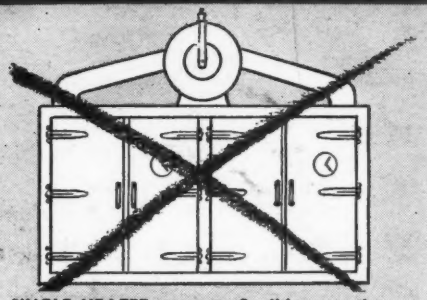
This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council

Why foundrymen prefer . . .

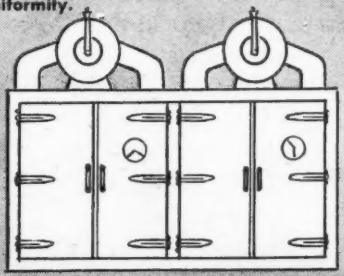
DESPATCH COMPARTMENT-TYPE OVENS WITH INDEPENDENT HEATERS

In foundries which keep tab of results obtained with multiple-compartment ovens, Despatch units with *independent* heater invariably rank first. Here's why they're preferred to ovens in which one heater must serve all compartments:

- **ASSURES GREATER FLEXIBILITY.** Allows independent baking in each compartment, same as in separate, isolated ovens. Permits handling more jobs, running large and small cores through without waiting, etc.
- **PROVIDES FASTER BAKING.** Cores bake faster as insertion of cold load in one compartment doesn't affect baking in other compartments.
- **IMPROVES HEAT UNIFORMITY.** Heatflow and recirculation are more direct and efficient; no off-balance baking can be caused by opening doors of other compartments.
- **ALLOWS MORE ACCURATE CONTROL.** Each heater operates in response to control instruments in one compartment only. Permits accurate control with temperature best suited to each load.
- **INCREASES EFFICIENCY, SAVES FUEL.** Eliminates need for bulky oversized heaters, shortens air-travel, helps cut fuel costs. Compartments can be completely shut off when not in use.



SINGLE HEATER prevents flexible operation as alternate loading slows up baking in both compartments, wastes fuel and destroys heat uniformity.



SEPARATE HEATERS, the Despatch way, allows independent baking in each compartment. Saves fuel, speeds baking, improves uniformity and affords more flexibility.

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OVEN COMPANY MINNEAPOLIS 14 MINNESOTA, U.S.A.

WRITE FOR DETAILS. Let us tell you how Despatch Foundry Ovens, in all sizes, types and for all fuels, can reduce your core baking costs.